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THE QUARTERLY REVIEW of BIOLOGY

REGENERATION OF THE LENS IN THE AMPHIBIAN EYE

By RANDALL W. REYER

Osborn Zoological Laboratory, Yale University and the Department of Anatomy, University of Pittsburgh School of Medicine

I. INTRODUCTION

AMONG the vertebrates, the Amphibia have provided the best material for the study of regeneration. This is particularly true of the urodeles, which exhibit a greater capacity for the replacement of lost parts than any other vertebrates. The regeneration of the limb, tail, parts of the brain, and eye are examples. The last mentioned is of particular interest, since the urodele eye is not a simple structure but a very complex, highly differentiated photoreceptor capable of mediating vision of considerable acuity. That the processes of regeneration in some species of urodeles can restore apparently normal vision after complete loss of both neural retina and lens (Wachs, 1920a, b; Stone and Zaur, 1940; Stone and Chace, 1941; Stone and Farthing, 1942; Stone, 1948, 1950d; Zalokar, 1944) was both unexpected and of great interest. This review will concern itself only with the regeneration of the lens. The equally important subject of retinal regeneration has been reviewed recently by Stone (1948, 1950a, b, c, d).

II. HISTORICAL

Colucci (1891) was the first to report the regeneration, in an amphibian, of a new crystalline lens from the pupillary margin of the dorsal iris following removal of the old lens. His experiment consisted in removing the distal (lateral) one-quarter of the eye, including the whole lens, in the adult *Triturus*. When these eyes were later fixed and studied in microscopic sections, Colucci found several stages in the growth of a new lens from the dorsal, pupillary margin of the reconstituted eye cup. In 1894 and 1895, Gustav Wolff published accounts of experiments on both larvae and adults of *Triturus taeniatus* and *T. cristatus* in which he removed the lens through a corneal incision. In 30 cases, both the extirpated lens and the eye were fixed immediately after the operation for study in serial sections. Since the extracted lens appeared to be intact and no trace of lens tissue was found in the eye, he concluded that complete removal of the old lens had been achieved. From the 100 cases preserved on successive days following the operation, Wolff (1895, 1901) described the changes occurring during lens regeneration from the iris. In considering the mechanism underlying this process, Wolff offered only a teleological explanation. Although regeneration of a lens from the margin of the dorsal iris has been called "Wolffian" lens regeneration, Colucci actually had priority in its discovery. Similar experiments were also performed by Müller (1896), Brachet and Benoit (1899), and Randolph (1900), including a further histological study of the extirpated lenses by the last mentioned author. All of the investigators mentioned so far worked on salamanders of the genus *Triturus*. Fischel (1900, 1903) ex-

tended the study to larvae of *Salamandra salamandra* (= *maculosa*). From his results, it would appear that lens regeneration occurred much more slowly in this animal.

Wachs (1914) made a careful study of lens regeneration in larvae of *Triturus taeniatus* and *T. cristatus*, carrying out several experiments to study the causal mechanisms underlying the process. Since this time, many investigators in several different nations have made contributions to our understanding of lens regeneration. In order to present the large amount of material more clearly and concisely, the work of the various investigators will be taken up as it bears upon the topics to be considered.

III. REGENERATION OF A LENS IN THE GENUS TRITURUS

A. Experiments on larvae and adults

1. Description of normal lens regeneration

Lens regeneration from the iris is now known to occur in larvae and adults of 13 species of the genus *Triturus* (*Triton*, *Diemyctylus*), namely, *T. alpestris* (Monroy, 1937; Stone, unpub.), *T. cristatus* (Wachs, 1914; Zalokar, 1944; Stone, unpub.), *T. ensicauda* (Kojima, 1939), *T. granulosus*, *T. helveticus*, *T. marmoratus*, *T. perstriatus* (Stone, unpub.), *T. pyrrhogaster* (Ogawa, 1921; Nakamura, 1935; Ikeda, 1936a; Sato, 1940; Mikami, 1941; Stone, unpub.), *T. rivularis*, *T. sierrae* (Stone, unpub.), *T. taeniatus* (Wachs, 1914; Woerdeman, 1922; Sato, 1930, 1940; Monroy, 1937; Stone, unpub.), *T. torosus* (Dinnean, 1942; Stone, unpub.), *T. viridescens viridescens* (Stone and Sapir, 1940; Stone and Chace, 1941; Reyer, 1948; Stone, 1952), and *T. viridescens dorsalis* (Stone, unpub.).

Sato (1940) designated thirteen stages in lens regeneration which were subsequently used by Zalokar (1944) and Reyer (1948, 1950). These can be applied with slight modifications to both larvae and adults and are as follows:

I. Latent period

Stage 1. Thickening of the iris, especially along the pupillary margin (Fig. 1B).

Stage 2. Further thickening of the dorsal part of the iris and formation of a cleft between the inner and outer laminae (Fig. 1C).

II. Initial period

Stage 3. First appearance of depigmented cells at the pupillary margin of the mid-dorsal portion of the iris (hereinafter referred to as the margin of the dorsal iris) (Fig. 1D).

Stage 4. Formation of a hollow epithelial vesicle of high cuboidal depigmented cells continuous with the epithelia of the outer and inner laminae of the iris. The nuclei lie approximately in the middle of the cells (Fig. 1E).

Stage 5. Elongation of the cells of the inner wall of the vesicle to form a columnar epithelium with nuclei lying near the basal side of the cells (Fig. 1F).

Stage 6. Earliest development of a few irregularly arranged lens fibers from cells of the inner vesicle wall (Fig. 1G).

III. Period of lens fiber differentiation

Stage 7. Beginning formation of the primary lens fiber nucleus, which projects from the inner wall into the lumen of the lens vesicle as a little hillock (Fig. 1H).

Stage 8. Completion of the primary lens fiber nucleus from the cells of the inner wall of the vesicle. This structure fills most of the lumen of the vesicle. The lens fibers on the outside of this nucleus are assuming a concentric arrangement, but, so far, no lens fibers have developed from the equatorial zone (Fig. 1I).

Stage 9. Beginning differentiation of secondary lens fibers from the equatorial zone of lens epithelium, where it meets the primary lens fiber nucleus. The secondary lens fibers surround the primary lens fiber nucleus except laterally (Fig. 2A).

Stage 10. Appearance of medial lens suture. The primary lens fiber nucleus is completely surrounded by a layer of secondary lens fibers which is still thinner laterally than medially (Fig. 2B).

Stage 11. Primary lens fiber nucleus now symmetrically enclosed by secondary lens fibers. The nuclei of the lens fibers are still visible in the middle of the lens (Fig. 2C).

IV. Period of Growth

Stage 12. Disappearance of the nuclei in the lens fibers of the primary lens fiber nucleus (Fig. 2D).

Stage 13. Disappearance of the nuclei in the fibers throughout most of the lens except in the younger, outermost portions (Fig. 2E).

In older embryos and young larvae, where the

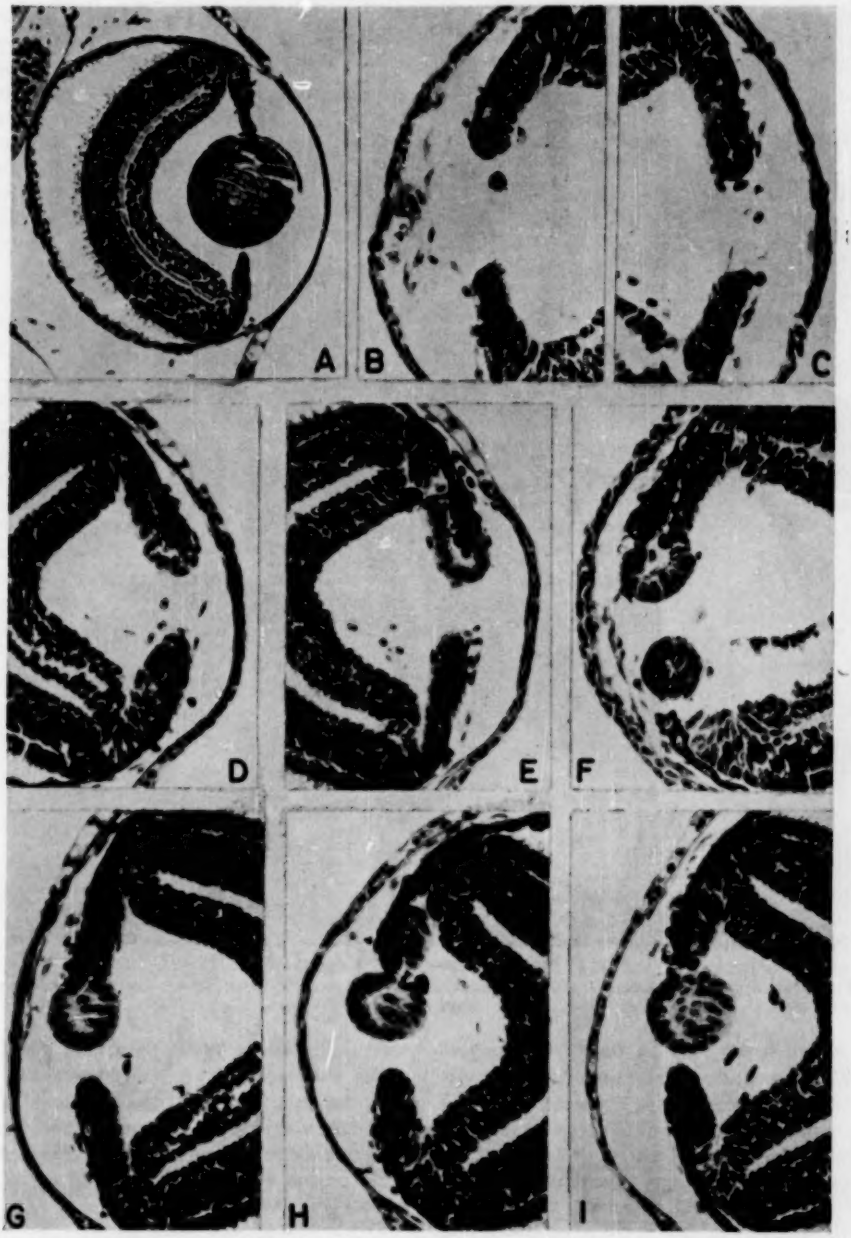

FIG. 1. STAGES IN THE REGENERATION OF A LENS FROM THE IRIS IN LARVAE OF TRITURUS VIRIDESCENS FROM 4 UNTIL 30 DAYS AFTER LENS EXTIRPATION

At the time of operation, the larvae varied in age from a stage with 3 finger-buds on the forelimb to one with long hindlimb buds. Magnification, × 135, except A. A, normal unoperated eye, × 90. B, stage 1, after four days. C, stage 2, after five days. D, stage 3, after six days. E, stage 4, after seven days. F, stage 5, after nine days. G, stage 6, after nine days. H, stage 7, after eleven days. I, stage 8, after eleven days.

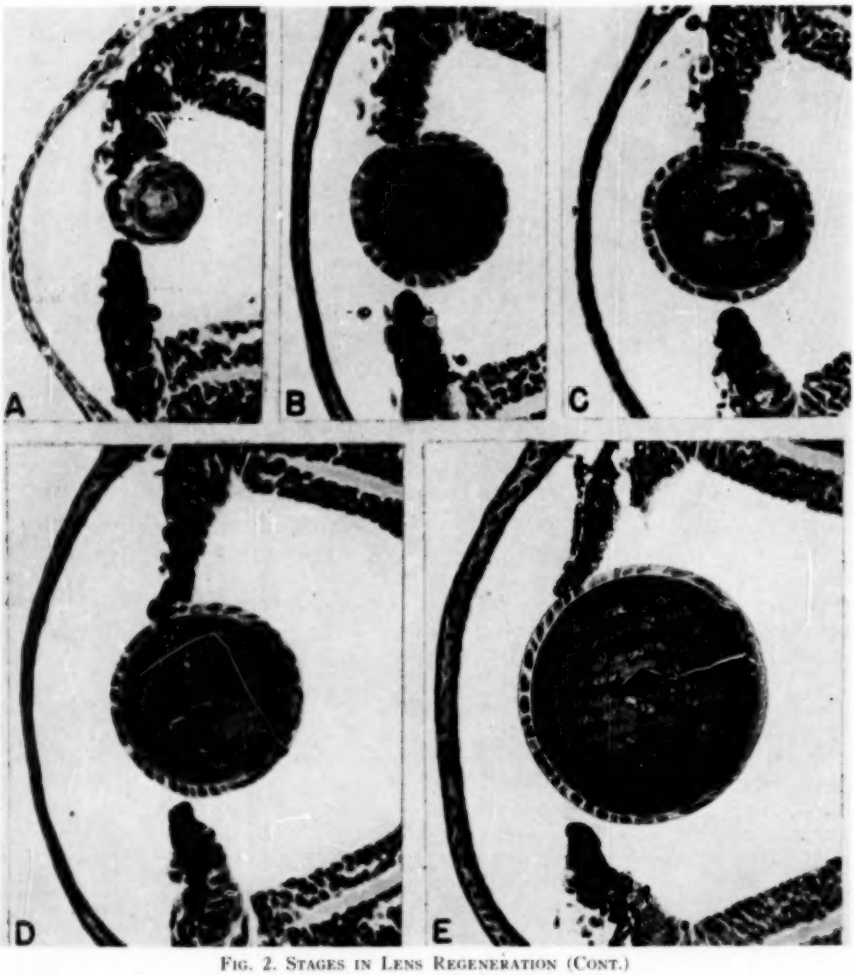

FIG. 2. STAGES IN LENS REGENERATION (CONT.)

Magnification, × 135. A, stage 9, after sixteen days. B, a late stage 10, after sixteen days. C, stage 11, after eighteen days. D, stage 12, after twenty days. E, stage 13, after thirty days.

iris is represented only by the thick, truncated margin of the optic cup, stage 1 cannot be observed. The first indication of lens regeneration at these ages is the appearance of a cleft between the outer and inner layers at the margin of the dorsal iris, thus stage 2. Furthermore, since pigment is found only in the outer layer of the iris, there is much less depigmentation than in old larvae and adults, where both iris laminae are densely pigmented (Reyer, 1948). In Dinnean's (1942) experiments on *Triturus torosus* larvae of an intermediate age, the inner lamina of the iris was pigmented for only a short distance from the pupillary margin; during lens regeneration, the pigment was lost from this part before the development of a depigmented vesicle at the iris margin. It would thus seem that the degree and pattern of the depigmentation process depends on the amount of pigment initially present in the iris.

Kojima (1939) and Sato (1940) described a variation which seems to occur in most but not all adults of *Triturus pyrrhogaster*. Initially, an unusually large cleft developed in the margin of the dorsal iris. As the lens vesicle formed, a rapid

growth of the outer wall caused it to be folded inwards so as to form a sharp angle with the surface of the iris. Due to this rotation of nearly 90°, the primary lens fibers developed from the mediodorsal part of the lens vesicle. During further growth, the lens gradually returned to a normal position. These changes in position resulted in an asymmetrical arrangement of the secondary lens fibers during the subsequent stages.

Very little work has been done on the metabolism of the regenerating lens. Takata (1952) studied the content of ribonucleic acid in the regenerating lens of adult *Triturus pyrrhogaster* by using a thionine or toluidine blue stain with or without prior treatment of the sections with ribonuclease. He found a strong cytoplasmic basophilia beginning with the first appearance of depigmented cells and continuing with no noticeable change in intensity until a well differentiated lens had formed 30 days after the operation. This basophilia was present to an equal extent in both the lens epithelium and the lens fibers. In the sections subjected to prior treatment with ribonuclease, no cytoplasmic basophilia was observed. In contrast to this, a ribonuclease-sensitive basophilia was not found in the cytoplasm of the normal adult lens of this animal. The author concludes that this basophilia is due to the presence of large amounts of ribonucleic acid which may be correlated with the synthesis of proteins during the growth and differentiation of the regenerating lens.

For an analysis of the rate of lens regeneration expressed in terms of the rate of morphological differentiation, it is necessary to use an adequate series of stages and a sufficient number of animals killed on successive days during the experiment so that the amount of variability can be roughly assayed. Of the studies listed previously, only those of Sato (1940), Zalokar (1944), and Reyer (1948) fulfill these requirements. Figs. 3 and 4 depict graphically the results of these studies, which deal with old larvae and adults. It can be seen from a comparison of these graphs that lens regeneration proceeded most rapidly in the *Triturus taeniatus* larvae, almost as fast in the *Triturus cristatus* larvae, somewhat slower in the *Triturus pyrrhogaster* and *Triturus viridescens larvae*, and much more slowly in the *Triturus pyrrhogaster* adults.

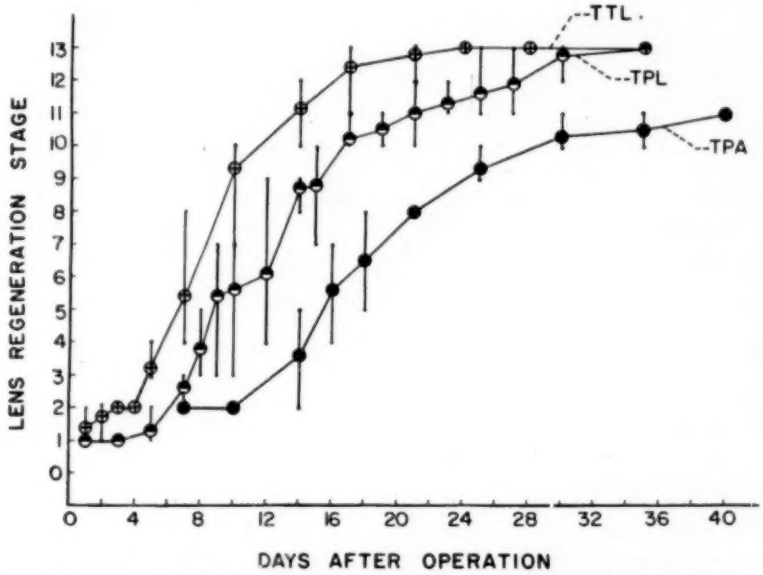

FIG. 3. RATE OF LENS REGENERATION IN OLD LARVAE OF TRITURUS TAENIATUS (TTL) AND TRITURUS PYRRHOGASTER (TPL) AND ADULTS OF T. PYRRHOGASTER (TPA)

The symbols ⊕, ◓, and ● mark the average regeneration stage for each day, while the vertical lines connect the extreme stages thereby indicating variability. *T. taenialus* larvae—151 cases; *T. pyrrhogaster* larvae—175 cases; *T. pyrrhogaster* adults—99 cases. (Modified from Sato, 1940).

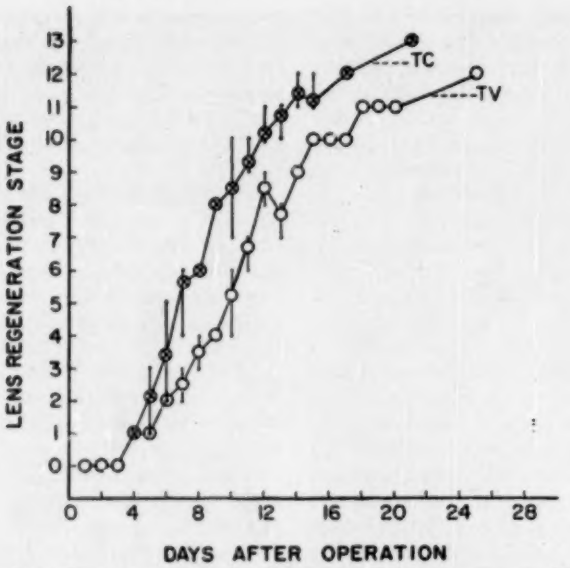

FIG. 4. RATE OF LENS REGENERATION IN OLD LARVAE OF TRITURUS CRISTATUS (TC, ⊗) AND TRITURUS VIRIDESCENS (TV, ○)

Data presented as in Fig. 3. *T. cristatus*—220 cases; *T. viridescens*—61 cases. (Data from Zalokar, 1944, and Reyer, 1948).

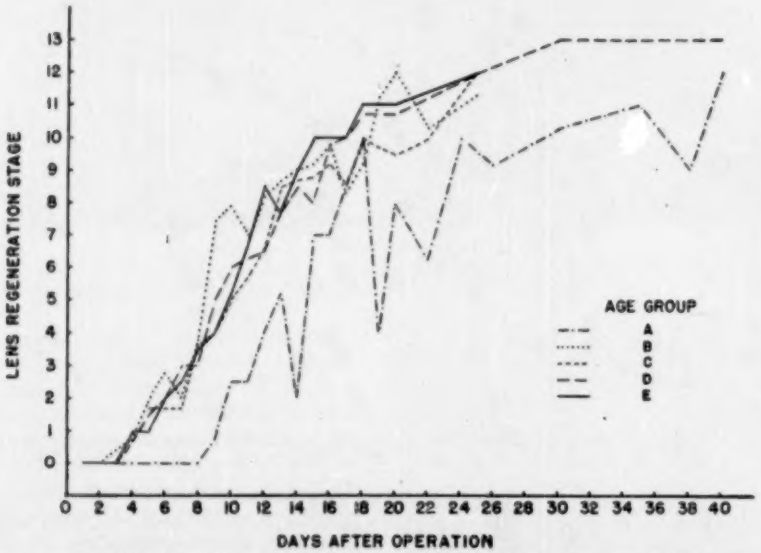

FIG. 5. AVERAGE RATES OF LENS REGENERATION FOR TRITURUS VIRIDESCENS LARVAE OF FIVE DIFFERENT AGES

See text. (From Reyer, 1948, reproduced by courtesy of the *J. exp. Zool.* and the Wistar Institute).

In *Triturus viridescens*, the rate of regeneration has been compared by the above method for larvae of several ages (Reyer, 1948). These age groups are as follows: (A) stages 34 to 36⁻, from gill-buds indicated to prominent gill-buds, forelimb-buds indicated; (B) stage 38, second and third gills with one or two buds; (C) stages 39 and 40, forelimb-buds slightly truncated, third gills with 4 to 6 branches and buds; (D) stages 46⁺ and older, from fourth finger-bud on forelimbs indicated and no hindlimb-buds, to long pointed hindlimb-buds (10 to 16 mm. long); (E) from fifth toe on hindlimbs indicated, to large fifth toe on hindlimbs (24.5 to 31.5 mm. long). In age groups B to E, not only the time from lens removal to the first appearance of a reaction in the dorsal iris, but also the rate of regeneration after its initiation, were approximately the same; in the youngest age group (A), there was a longer latent period between the time of operation and the first appearance of changes in the eyecup margin, but the rate of regeneration, once begun, was nearly as fast as that in the four older groups (Fig. 5). The amount of variation in the stage of lens regeneration attained by different animals fixed a given number of days following lens extirpation was greater, the younger the age group. These results are in disagreement with those of Wachs (1914, 1920a) and of Monroy (1937), who reported that the rate of lens regeneration increased with larval age until just before metamorphosis.

The work just discussed has dealt only with the rate of differentiation of the lens. It is customary to study growth rates in terms of the increase in volume or weight with respect to time. Such a study is difficult in the case of the regenerating lens for the following reasons: the preparations are confined to histological serial sections; the regenerating lens is not spherical and changes its shape during growth; in the early stages, the lens vesicle is hollow. However, a rough idea of the size of the developing lens can be obtained by measuring, in fixed and sectioned material, the three main axes of the lens (Sato, 1940; Zalokar, 1944; Reyer, 1948). It was found that, as the developing lens differentiates, it also increases in size and changes from spheroidal to spherical in shape. Furthermore, the size of the lens at a particular stage of differentiation is smallest in a young larva, larger in an older, bigger larva, and largest in a full-grown adult.

Sato (1940) made a more detailed study of growth rates. He plotted the absolute size and the relative size of the regenerating lens not only against stage of regeneration but also against days since lens extirpation. For each stage of differentiation, the absolute size of the lens of the *Triturus taeniatus* larvae was smallest, that of the *Triturus pyrrhogaster* larvae slightly larger, and that of adult *Triturus pyrrhogaster* much larger. However, the relative size for each differentiation stage was approximately the same for all three. It would thus appear that the progress of differentiation is influenced by the size of the regenerate relative to that of the normal lens.

Absolute size is the average of the three main axes of the lens; *relative size* is the ratio, expressed in per cent, obtained by dividing the absolute size of the regenerating lens by the size of a normal lens of an animal of equal length.

When plotted against days after operation, the regenerating lens in the *T. taeniatus* larvae started to grow before that in the *T. pyrrhogaster* larvae and grew more rapidly until about the 17th day, at which time its rate of growth dropped so that the absolute size of the lenses of the two species was approximately equal after 25 days. The lens of the adult *T. pyrrhogaster* started to grow later, but its growth in absolute size was much more rapid than that of either of the larvae and continued much longer. Therefore, it attained a much larger size (Fig. 6). When these growth rates were considered in relation to the size of the normal lens (growth in relative size), the *T. taeniatus* larval lens was seen to maintain its lead over the *T. pyrrhogaster* larval lens. The rate of growth in relative size of the *T. pyrrhogaster* adult lens was approximately the same as that of the larva of the same species. However, due to the longer latent period in the adult, its lens had a smaller relative size on any given day of regeneration (Fig. 7). This confirms the results of Monroy (1937), but is not in agreement with his conclusion that the relative growth rate decreases with increasing age and size of the animal. It would appear that Monroy neglected to take into account the fact that the latent period is much longer in adults than in larvae. Furthermore, he determined the relative size of the regenerating lens in his larval and adult animals only for those killed 17 days after lens removal. In ascertaining such a growth rate, it is necessary to calculate values for relative size for several different intervals of time after the operation, as was done by Sato.

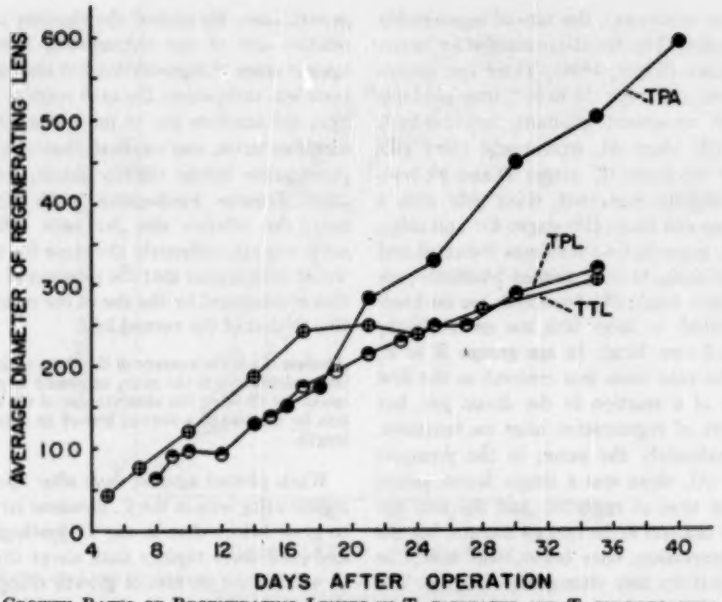

FIG. 6. GROWTH RATES OF REGENERATING LENSES IN T. TAENIATUS AND T. PYRRHOGASTER LARVAE AND T. PYRRHOGASTER ADULTS

Growth in absolute size. Species and ages the same as presented in Fig. 3. Ordinate, average diameter of the regenerating lens in microns. (Modified from Sato, 1940).

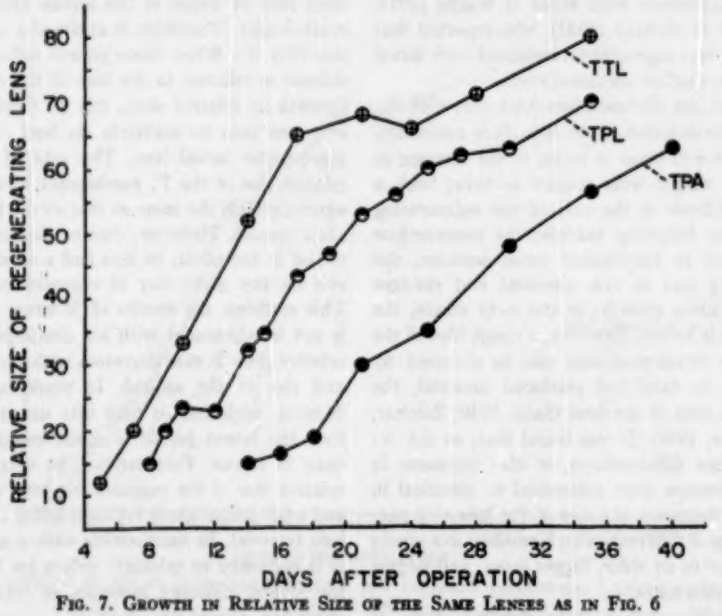

FIG. 7. GROWTH IN RELATIVE SIZE OF THE SAME LENSES AS IN FIG. 6

Ordinate, relative size of the regenerating lens in percentage. (Modified from Sato, 1940).

The cause of this increased latent period in the adult may possibly be due to a more advanced differentiation of the iris in the older animal, thus requiring a longer time for "dedifferentiation" to take place. It can be concluded that, although growth in absolute size is more rapid in the regenerating lens of the adult animal than in the larva, yet differentiation is slower in the adult due to a longer latent period and the dependence of differentiation on the regenerate's attaining a certain size relative to the normal lens. During the first 6 months at least, the regenerated lens in the adult never becomes as large as the normal lens (Capraro, 1936; Stone and Chace, 1941).

Some of the other authors obtained rates of lens regeneration which varied considerably from those shown in Figs. 3 and 4. In *T. torosus* larvae, Dinnean (1942) observed a slower rate than that occurring in the larvae previously discussed. Zalokar (1944) found a more rapid rate in adult *T. cristatus* than had Sato (1940) for adult *T. pyrrhogaster*, while Ikeda (1936a) observed a much slower rate and Mikami (1941) a still faster one in adults of the latter species. The question at once arises as to possible causes responsible for these discrepancies. Two factors appear likely, differences in temperature and differences in the species or local races of animals used. The question of temperature has not yet been adequately studied, but the work of Nakamura (1935) indicated its importance. Using adult *Triturus pyrrhogaster*, he found that, in April, with a mean temperature of 12.5°C., the beginning of depigmentation occurred after 30 days, while in July, with a mean temperature of 27.5°C., depigmentation was initiated after only 10 days and lens fiber formation began after 15 days. These results could be duplicated without regard to season in a refrigerator at 8–15°C. and in an incubator at 27.8°C. For a thorough analysis of this question, lens regeneration should be studied in a large series of animals, both larvae and adults, cultured under several different constant temperatures. Both the change in rate of differentiation and in rate of growth in size of the regenerating lens with respect to temperature should be investigated.

At this point, it would be well to mention that, in the regeneration rates compared graphically in the beginning of this section, only the experiments on larvae of *Triturus taeniatus* and *Triturus cristatus* were conducted under constant temperature conditions, 24°–25°C. for the former and 22°–23°C. for the latter. The temperature in the studies on *Triturus pyrrhogaster* was quite variable, being reported by Sato as approximately 28°–35°C. (average slightly over 30°) for the larvae and 22°–30°C. for the adults. The experiments on *Triturus viridescens* larvae were conducted at laboratory room temperature, which was also quite variable, approximately 18°–24°C.

2. The stimulus initiating lens regeneration

The visible alterations in the dorsal iris that mark the beginning of lens regeneration appear a few days after lens extirpation. Therefore, upon removal of the lens, certain changes must occur within the eye that set in motion the replacement of this body from a tissue seemingly highly differentiated along entirely divergent lines. To Wolff (1895, 1901), here was an example of the replacement of a needed structure which was initiated by the simple fact of its absence and was explainable only on vitalistic, teleological grounds by an appeal to a final cause. Fischel (1900, 1903) was the first to propose a physiological mechanism, namely, injury to the iris upon removal of the lens. However, his experimental evidence was not critical, and further work appears to have eliminated this theory. Very early, Wolff (1904) showed that injuries to the dorsal iris failed to initiate lens development from the iris if the old lens remained intact; this result has since been confirmed by Stone (1943, 1952). Removal of the dorsal iris margin did not prevent lens regeneration if followed by extirpation of the normal lens (Ciaccio, 1936; Stone, 1943). However, repeated removal of the dorsal iris can check lens regeneration completely (Ciaccio, 1936). Lens regeneration occurred just as readily when the lens was removed through the vitreous chamber and eyeball, either dorsally (Zalokar, 1944) or into the mouth cavity (Wolff, 1901; Sato, 1930), as when pulled out through the pupil and cornea. When the lens was removed and reimplanted immediately, no lens regeneration ensued if the reimplanted lens came to occupy its old position and remained intact and healthy (Wachs, 1914; Ikeda and Kojima, 1940; Ikeda and Amatatu, 1941; Dinnean, 1942; Uno, 1943; Stone, 1943; Zalokar, 1944). Similar results were obtained following dislocation of the lens with subsequent return to its normal position (Uno, 1943). The theory of Uhlenhuth (1919, 1920) that depigmentation and subsequent lens formation is brought about by

rupture of an iris membrane during lens extirpation and consequent exposure of the dorsal iris cells to the fluids of the eye chamber is equally untenable.

Two other theories have been proposed to account for the initiation of lens regeneration. These are: (1) removal of some chemical or metabolic action on the part of the lens, and (2) removal of the mechanical pressure exerted by the lens as a large solid body within the eye and lying in contact with the margin of the iris. The majority of evidence available favors the first hypothesis, but the results reported by a few authors point to a possible role of the second. It may be that both factors are involved. In the analysis of this question, two types of experiment have been used: (1) experiments in which the course of lens regeneration is studied when under the influence of lens tissue other than the normal lens and usually not duplicating the spatial relations of this body; (2) experiments in which attempts are made to duplicate the spatial relations of the normal lens by replacing it with some other foreign body. Those of the former group will be considered first.

If the lens was injured with forceps and allowed to remain in the eye (Ikeda and Amatatu, 1941), or if the eyeball of the adult animal was removed and then replaced in the orbit so that the blood supply was cut off temporarily (Stone and Chace, 1941), degeneration of the lens took place. Subsequently, lens regeneration from the dorsal iris occurred but was delayed when compared to the results following simple removal of the old lens. As mentioned before, removal of the lens followed by its reimplantation resulted in complete suppression of lens regeneration when the lens remained healthy and lay in its normal position. According to Dinnean (1942), even cystic lenses completely inhibited lens regeneration but Ikeda and Amatatu (1941), Uno (1943), and Stone (1952) reported delayed regeneration in the presence of a degenerating lens. Zalokar (1944) observed, in addition, that a reimplanted lens lying a short distance (10 to 45 μ) from the iris and hence exerting no pressure on its margin could completely inhibit lens regeneration, although, if further away, a delayed, rather abnormal attempt at regeneration occurred. When another lens was implanted two to 7 days after lens extirpation, an inhibited attempt at regeneration occurred in most cases. Although considerable variability obtained, both in the distance of the lens from the iris and in the extent of lens regeneration, the general result was that the process of regeneration was arrested at the stage it had attained at the time of reimplantation, and any further differentiation took place abnormally if at all. Similar results were observed in a few cases by Wachs (1914) after implanting a lens smaller than the normal lens just removed. When the lens regeneration from the iris was allowed to proceed longer before implantation of a lens (6 to 22 days), then the amount of inhibition of this regeneration was found to drop sharply after a 22-day delay, i.e., when the regenerating *Triturus pyrrhogaster* lens had reached approximately stage 7 (Ikeda and Kojima, 1940).

In experiments by Reyer (1948) on young larvae, removal of the soft lens was occasionally incomplete. Such fragments sometimes reconstituted quite normal-appearing lenses, which either completely inhibited lens regeneration or limited it to the initial stages of depigmentation. In a similar fashion, large masses of lens tissue (diam. 50 to 130 μ), which were embedded in the surface of the retina, still prevented lens regeneration in most cases, while similar small bodies (diam. 0 to 50 μ) exerted no inhibitory effect. These results provide evidence for the operation of a quantitative factor in the inhibition of lens regeneration by other lens tissue.

This inhibitory action does not appear to be limited to the lens of *Triturus* but is present also in the lens of *Amblystoma punctatum*, a species in which lens regeneration does not normally occur. By exchange of the prospective lens anlage in the embryo and by lens transplantation in larvae, Stone (1945) obtained *Triturus* eyes with *Amblystoma* lenses. There was no lens regeneration in the *Triturus* eye until after the removal of the *Amblystoma* lens, at which time regeneration then took place in normal fashion. Similarly, the lenses of *Triturus ensicauda*, *Hynobius nebulosus*, and, to some extent, of the anuran *Bombina orientalis* were found to prevent lens regeneration in *Triturus pyrrhogaster*, as did also the lens of *T. pyrrhogaster* in the eye of *T. ensicauda* (Ikeda and Kojima, 1940; Uno, 1943).

Another method of analysis has stemmed from the discovery by Wachs (1914) that, when a piece of dorsal iris was cut out and implanted into the eye chamber following lens extirpation, a lens would regenerate from the margin of the free iris piece as well as from the iris in situ. This resulted either in two separate lenses or else in a double lens

if the two had fused (Fig. 8A). This technique, in which the iris piece is implanted either into its own or into another eye, has been used for the study of several aspects of lens regeneration, among them the inhibitory role of the lens factor (Sato, 1930, 1935; Mikami, 1941; Uno, 1943; Stone, 1943, 1952). It was shown by Wachs (1914) and Stone (1943, 1952) that a piece of dorsal iris, implanted into an eye without disturbing the normal lens, remained intact and showed no sign of lens formation. However, Uno (1943) obtained the development of abnormal lentoids from 13 to 14 per cent of similar grafts implanted into the vitreous chamber even though the host lens was still present. No such lens development occurred from the iris grafts implanted into the anterior chamber. The author cites this as evidence for a decline in the inhibitory action of the lens in the more distant parts of the eye chamber. Further experiments have consisted of lens extirpation from the host eye followed by delayed implantation of the piece of iris from the donor or, conversely, implantation of pieces of iris allowed to initiate lens regeneration following an earlier removal of the lens from the donor eye. Using the former method on larvae of *Triturus taeniatus*, Sato (1935) implanted pieces of dorsal iris after a delay of 1 to 17 days; this was followed by culture for 17 to 22 days before killing. After a 1- to 5-day delay in implantation, cases of lens regeneration from the graft, with formation of lens fibers, were found. No such cases occurred after a delay of 7 days or more, although a few grafts still developed depigmented vesicles. Stone (1943, 1952) and Mikami (1941) employed both types of experiment mentioned above on adults, with somewhat different results. Stone observed that a regenerating lens did not inhibit another one in the same eye unless it had a head start of at least 25 to 30 days (Fig. 8B, C). With a 32-day disparity, inhibition was complete. Mikami did not extend the age difference that far and still obtained, in 50 to 60 per cent of the cases, lens regeneration from the graft or dorsal iris in situ in the presence of a second regenerating lens with a head start of up to 23 days. A possible explanation for the discrepancy between the results of Sato and those of the other two authors may lie in the difference in size of the larval and adult eye chambers. A larger regenerating lens might be required to exert an inhibitory effect throughout the larger space in the adult eye. Some slight support for this hypothesis can be derived from a statement by Mikami that, where the iris and the regenerating lens lay in contact, there was no lens regeneration from the former. However, no actual data were given. Another possible factor might be the more rapid differentiation of the regenerating lens in larvae as compared to adults. Thus, a stage capable of exerting an inhibitory effect might be reached sooner in the former than in the latter.

Probably the most critical evidence for the "lens factor" comes from recent experiments by Stone and Vultee (1949). In this study, aqueous humor, taken from eyes containing normal lenses, was injected into eyes from which the lenses had been removed. Prior to each injection, aqueous humor, equal in volume to that added, was removed from the eye of the recipient animal (pers. com.). Lens regeneration was prevented in these eyes up to 97 days after lens extirpation and commencement of the injections. In control experiments, daily injections of Ringer's solution did not interfere with lens regeneration.

The experiments made to test the role of changes in the spatial and pressure relationships within the eye in initiating lens regeneration have not yielded entirely consistent results. Spherical objects the size of a lens, viz., alcohol-fixed lens (Wachs, 1914), fixed, paraffined lens (Kesselyák, 1936), or wax spheres (Stone, 1945), have been implanted into eyes following lens removal in an attempt to duplicate, in the absence of a living lens, the normal spatial configuration of the lens and iris. Even when retained in the space normally occupied by the lens, these objects failed to prevent lens regeneration from the host dorsal iris. In the experiments of the first two authors, however, they did delay its progress, particularly the formation of lens fibers, although no delay at all was observed by Stone. Spirito and Ciaccio (1931) reported 7 cases where a new lens was beginning to regenerate from the dorsal iris in the presence of the old lens after a silver or glass cylinder had been placed between the dorsal rim of the iris and the old lens so that these parts of the eye were separated by a space. After 34 days, the regenerating lens had developed lens fibers and was detached from the iris. These authors concluded that a space between the iris and the lens is sufficient to release lens regeneration from the former. Uno (1943) also observed a very few cases where retarded lens regeneration had been initiated when a seemingly healthy reimplanted lens was separated from the iris margin by a space. How-

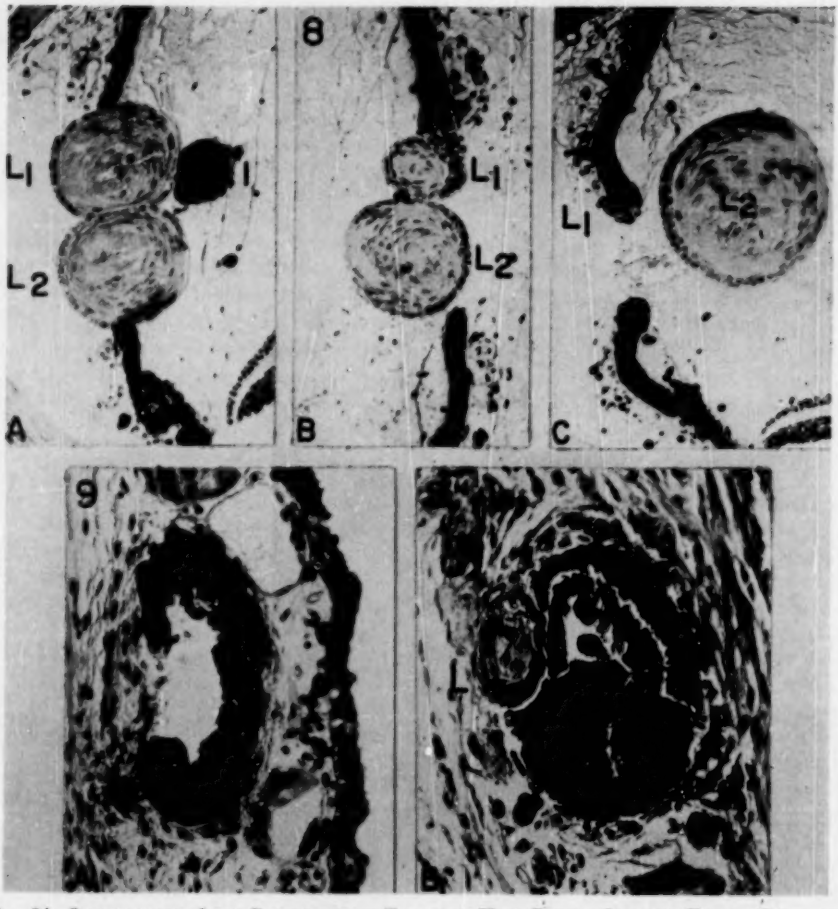

FIG. 8A. SIMULTANEOUS LENS REGENERATION FROM THE HOST DORSAL IRIS AND FROM A PIECE OF MID-DORSAL IRIS IMPLANTED INTO THE SAME EYE CONCURRENTLY WITH LENS EXTIRPATION IN ADULT TRITURUS VIRIDESCENS

30 days after operation. I, iris graft, L_1, lens from host dorsal iris; L_2, lens from iris graft. × 70. (From Stone, 1952, reproduced by courtesy of the *J. exp. Zool.* and the Wistar Institute).

FIG. 8B. NORMAL DEVELOPMENT OF A LENS FROM THE HOST DORSAL IRIS FOLLOWING REMOVAL OF THE OLD LENS AND IMPLANTATION OF A PIECE OF DORSAL IRIS WITH A 20-DAY-OLD REGENERATING LENS

There has been no inhibition of either host or graft regenerating lens, 22 days after operation. × 70. (From Stone, 1952, reproduced by courtesy of the *J. exp. Zool.* and the Wistar Institute).

FIG. 8C. RETARDED DEVELOPMENT OF A LENS FROM THE HOST DORSAL IRIS FOLLOWING REMOVAL OF THE OLD LENS AND IMPLANTATION OF A PIECE OF DORSAL IRIS WITH A 25-DAY-OLD REGENERATING LENS

22 days after operation. × 70. (From Stone, 1952, reproduced by courtesy of the *J. exp. Zool.* and the Wistar Institute).

FIG. 9A. PIECE OF DORSAL IRIS OF ADULT TRITURUS VIRIDESCENS 50 DAYS AFTER SUBCUTANEOUS IMPLANTATION ON THE SIDE OF THE BODY

No indication of lens regeneration was observed. × 125. (From Stone, unpub.).

FIG. 9B. PIECE OF DORSAL IRIS OF ADULT TRITURUS VIRIDESCENS EMBEDDED IN THE INNER SURFACE OF THE BODY WALL 30 DAYS AFTER IMPLANTATION INTO THE BODY CAVITY

A lentoid has developed from the margin. (L, lentoid). × 125. (From Stone, unpub.).

ever, see the results of Zalokar (1944) already discussed.

That the presence of a space at the margin of the dorsal iris has an influence on the occurrence of lens formation is indicated by several other experiments. Ikeda (1934b) mentioned that lens regeneration from the dorsal iris of the host eye was prevented when a piece of implanted iris was stuck to and completely covered its inside surface (graft iris from a species incapable of lens regeneration), and Ogawa (1921) observed failure of lens regeneration when the margin of the dorsal iris was fused to the corneal wound. Mikami (1941) implanted pieces of retina, brain, liver, and heart into the lensless eye. When the liver or heart implants were in close contact with the edge of the iris, complete suppression of lens regeneration ensued; when they were separated from the iris margin, lens regeneration was found to take place. Brain and retina were less effective. In fact, Mikami stated that "the retina accelerates the regeneration remarkably, if it is inserted into the pupil without touching the iris edge." Unfortunately, no details were given concerning this interesting observation.

Similar implantations of inert substances, talcum powder, glass powder, silica gel, a glass ball, pieces of agar, and kaolin were performed by Zalokar (1944). If the first four substances filled the eye chamber almost completely, then lens regeneration was retarded but not prevented, while agar completely prevented lens regeneration if it filled the eye and pressed against the iris. Kaolin, however, could entirely suppress lens regeneration if it occupied only two-thirds of the eye chamber without coming into contact with the dorsal iris at all.

Mikami interpreted his results as due to the pressure exerted on the iris by the implanted material. On the basis of his kaolin experiment, Zalokar disagreed with this. He explained his results, as did Kesselyák (1936), in terms of the availability to the regenerating lens of a substance produced by the retina and passing through the eye chamber. According to this hypothesis, a material such as agar, interposed between the iris and retina and tending to isolate the former, will result in inhibited lens regeneration or, if the isolation is complete, in its suppression. However, the action of kaolin must have been of a different nature, since the iris was still exposed to the fluids in the eye and was not isolated from any retinal influence. Zalokar concluded that kaolin acts by adsorbing the retinal substance and that the action of the lens may be similar; subsequent destruction of the adsorbed chemical may occur during the metabolism of the lens.

Of some interest also are preliminary attempts to inhibit lens regeneration by implanting pure chemicals. Zalokar (1944) obtained no inhibition when using reducing substances in an agar carrier, viz., glutathione, glutathione plus vitamin C, vitamin C alone, cystine, or cysteine plus vitamin C. However, Stone and Vultee (1949) were able to prevent lens regeneration for 4 to 5 months by placing a crystal of a carcinogen, methylcholanthrene, 9-10 dimethyl 1-2 benzanthracene, or 1-2-5-6 dibenzanthracene, in the pupil after lens extirpation.

What conclusions can be drawn from these experiments? The evidence for a simple mechanical action on the part of the lens is certainly tenuous; all of the examples that can be cited in its favor can be equally well explained on a different basis. As suggested by Uno (1943), it can be concluded tentatively that pressure on the margin of the dorsal iris acts not as a specific inhibitor for lens regeneration, but merely in a general mechanical way. In contrast, a specific action of the lens through some more subtle mechanisms has considerable experimental support in spite of numerous discrepancies in the evidence. However, the exact nature of this action still remains unknown. It may be a chemical secretion, either an inhibitory agent in itself or else one that neutralizes the stimulating action of another retinal substance. It may equally well be the result of peculiarities in the metabolism of the lens not necessarily mediated by the secretion of a specific chemical inhibitor or, as Zalokar has suggested, merely a physical adsorption of the stimulating agent produced by the retina. Whatever its nature, its action appears to depend on the size and physiological condition of the lens as well as on its distance from the reacting iris tissue.

3. The influence of the ocular environment and retina

In the preceding section, reference was made to the possibility that there is present in the eye chamber some product of retinal activity which stimulates the iris to begin lens regeneration and is necessary for the maintenance of this process. Here again the evidence for the action of such a

substance is not conclusive, but it is at least indicative.

Wachs (1920b), Zalokar (1944), and Stone (1950a, c) removed from the eyes of *Triturus taeniatus* and *T. cristatus* larvae and *Triturus viridescens* adults the entire neural retina in addition to the lens. Within the space of a few weeks, an entirely new neural retina developed from the pigmented layer of the retina by a process of depigmentation and of multiplication and migration of cells with final differentiation into the characteristic layers. Concurrently with this, a lens regenerated from the margin of the dorsal iris. However, in Zalokar's experiments, there was a small but definite lag in the initiation of lens regeneration over that observed following lens extirpation only, 1 to 3 days (2.2 days average), so that stage 3 was observed after 7 to 8 days instead of after 5 to 6 days. Following this delay, lens regeneration occurred at the same rate as after simple lens removal. In his studies, the appearance of new retina at the pars ciliaris retinae could be seen for the first time 5 days after the operation. Therefore, in spite of this short delay, lens regeneration was still initiated concurrently with retinal regeneration rather than following it. If the presence of neural retina is essential to lens regeneration, then either a very small amount of regenerated retina must have been sufficient or else the method of operation (expulsion through a dorsal wound by pressure on the cornea) left behind in the ciliary region some neural retina which acted in the initial stimulation of the dorsal iris. A generalized effect of operative injury would seem to be ruled out by experiments in which larger fragments of retina were left behind in the eye, or the whole retina was removed and then reimplanted. Under these conditions, little or no delay in lens regeneration occurred unless the implanted retina became reversed (the ganglion cell layer facing the pigmented retinal epithelium), in which case lens regeneration was greatly suppressed. Zalokar cited the latter observation (one case only) as evidence for localization of the retinal factor in the internal layers.

A much longer retardation in lens regeneration (stage 1 to 4 appearing only after 21 days, 10 and 11 after 61 days) occurred when grafts, consisting of the lateral part of the eyeball and comprising cornea and iris but without retina, were made to the forehead. In these cases, a delay equal to that noted for the lens was observed in the regeneration of the pigmented and neural retina (Zalokar, 1944). Experiments of Stone and Chace (1941) and Stone (1950b) on adult *Triturus viridescens* entailed degeneration of both retina and lens, due to cutting off the blood supply during reimplantation or transplantation of the whole eye. Regeneration of the retina was not distinct until approximately 20 to 27 days after the operation, at which time a layer of new retinal cells could be seen lining the eye chamber. At this time, a new regenerating lens of about stage 8 was developing from the dorsal iris. Twenty days after simple lens removal, a stage 10 to 11 lens regenerate could be observed.

The results just discussed can be interpreted in terms of a factor, necessary for lens regeneration, which is produced by the retina. A difficulty for this interpretation lies in the fact that lens regeneration seems to be initiated at nearly the same time as retinal regeneration rather than after the appearance of a well defined layer of new neural retina, as might be expected. The best way to resolve this difficulty would be the maintenance of the iris for a long period of time in the absence of both lens and retina. That changes do occur in the metabolism of the retina during the regeneration of a new lens is indicated by the results of Pósalaky et al. (1951), who found, by histochemical studies, an increase in the alkaline phosphatase activity of the retina beginning 5 days after lens removal, a maximum on the 14th day, at the time of lens fiber formation, and subsequently a decrease. Microchemical studies on whole eyes confirmed these results and showed an 83 per cent increase in the enzyme activity of experimental over contralateral control eyes on the 14th day after lens removal.

The experiments of Wachs (1914), Sato (1930, 1935), Stone (1943, 1952), and Mikami (1941), involving lens regeneration from pieces of dorsal iris lying free in the eye chamber, have already been mentioned. Whatever influence is present in the ocular environment is certainly able to act without cellular continuity between the host eye and the graft iris. Mikami (1941) obtained some interesting results indicating that, within the eye of an adult newt, some locations are much more favorable for lens regeneration from a dorsal iris fragment than others. These results are shown in Fig. 10 and in Table 1. The best site was within the immediate vicinity of the pupil itself; there was a sudden fall in the percentage of lens regeneration in the anterior chamber, and a more gradual one inwardly into the vitreous chamber,

with again an increase as the retina itself was reached. This difference was noted not only in the percentage of lens regeneration, but also in the size of the lens developed from the graft iris compared to that developed from the host iris and in the type of differentiation undergone by the developing lens (35 days after the operation in some cases, the time not given for others). The lenses lying in the vitreous chamber had well developed lens fibers but lacked a lens epithelium, while those in the anterior chamber consisted of epithelial vesicles containing very poorly differentiated lens fibers. These differences were not noticed by Wachs or Sato and may not occur in the smaller eye chamber of larvae.

The attempts to culture pieces of dorsal iris completely isolated from retina have led to somewhat conflicting results. In the experiments of Monroy (1939), grafts of larval dorsal iris or dorsal iris plus adjacent retina into subcutaneous pockets were either lost or showed little growth. Similar grafts into the enucleated orbit failed to regenerate a lens although they remained intact, and neural retina frequently developed even in those cases where none was believed to have been included with the graft. However, out of 24 cases in which dorsal iris and adjacent retina, obtained from a very young larva, had been grafted into the ear labyrinth, Wachs (1914) found a small lens in two cases and a lentoid in four. Since neural retina was present, and there is also some uncertainty as to whether these lenses developed from the iris or from a fragment of the soft, young lens included with the transplants, these results are not critical for the question at hand.

Stone (1943 and unpub.) repeated these experiments by implanting mid-dorsal iris pieces from

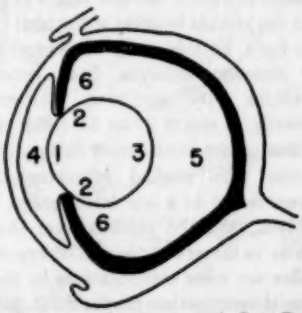

FIG. 10. DIAGRAM SHOWING THE SIX DIFFERENT REGIONS OF THE EYE CHAMBER WHERE IMPLANTED IRIS PIECES WERE FOUND (Modified from Mikami, 1941).

TABLE 1

Comparison of lens regeneration from pieces of mid-dorsal iris implanted into different locations within the eye chamber (Fig. 10)

"Relative size" is the ratio obtained by dividing the size of the lens developed from the graft iris by the size of the lens regenerated from the host iris in the same eye. (Data selected from Tables 3 and 4, Mikami, 1941).

LOCATION IN THE EYE (Fig. 10)	NO. OF GRAFTS AVAILABLE	NO. OF LENSES REGEN.	PERCENTAGE LENS REGEN.	NO. OF CASES MEASURED	MEAN RELATIVE SIZE OF REGEN. LENS
1	32	26	81	11	0.71
2	50	33	66	—	—
3	22	12	55	—	—
4	35	14	40	8	0.285
5	22	7	32	8	0.294
6	18	8	44	—	—
Retina	14	9	64	7	0.31

adult *Triturus* eyes either under the body skin or into the body cavity. In 44 of the 47 cases, fixed from 18 to 52 days after operation, there was no evidence of lens development from the implanted piece of iris (Fig. 9A, p. 12). However, in 3 cases, small lentoids with a few lens fibers were found attached to the margin of the transplanted iris (Fig. 9B). Two similar cases were also observed among 25 experiments in which the pieces of iris were transplanted to the same sites but 6 to 7 days following removal of the lens from the donor eye. Contrary to the results reported by Wachs and Monroy, no neural retina developed from the iris transplants in any of these cases. Stone considers that these few lentoids represented inhibited attempts at lens formation by the iris, independent of the action of the eye environment.

In a careful study on *Triturus pyrrhogaster* adults involving 133 cases, Ikeda (1935, 1936a) obtained good evidence that not until the regenerating lens has developed into a vesicle of columnar cells (stage 5) can it continue its differentiation when grafted into an extra-ocular site, in this case the 4th brain ventricle of *Hynobius nigricens* larvae, even though neural retinal tissue had usually developed from the ciliary margin of the grafted iris. When implanted earlier, such regenerative changes as had already taken place, subsequently disappeared.

This eye environment factor is also present in the eyes of three other species of urodele (*Hynobius unnangso*, *H. nebulosus*, and *Amblystoma*

punctatum) in which lens regeneration from the iris does not occur in the larval stage. When a piece of *Triturus* dorsal iris was implanted directly into an eye of a *Hynobius* or *Amblystoma* larva from which the lens had been removed, the grafted iris regenerated a lens in the same way as if implanted into a *Triturus* eye, although the iris of the host did not regenerate a lens. In the reciprocal experiment where a piece of the dorsal iris of *Hynobius* or *Amblystoma* was implanted into the lensless eye of *Triturus*, regeneration took place from the host iris but not from the graft (Ikeda, 1934b; Amano and Sato, 1940; Reyer, 1953). Furthermore, this property of the *Hynobius* eye is retained, but with decreased effectiveness, over a considerable period of time in the absence of the lens. When implantation of the iris graft was delayed until 50 to 60 days after extirpation of the lens, then lens formation from the graft was observed in 11 per cent of the cases, as compared to 50 per cent following its immediate implantation (Amatatu and Fujita, 1941).

Although these results are not in complete agreement, it can be concluded tentatively that the eye environment provides a stimulus for the initiation of lens regeneration. Without this stimulus, the iris usually fails to exhibit its capacity for lens formation. After stage 5 in regeneration has been reached, however, the lens vesicle is, in a sense, "determined" for lens and can proceed with lens differentiation in a suitable environment other than the eye chamber. Apparently the necessary conditions in the eye chamber, whatever they are, are found not only in eyes themselves capable of lens regeneration from the dorsal iris but also in some eyes that are incapable of this regeneration (at least in the stage used for these experiments; see later discussion of lens regeneration in *Hynobius* and *Amblystoma*). However, it would seem premature to attribute this condition in the eye chamber to a secretion produced specifically by the retina or to attempt, at this time, to homologize it with any hypothetical substance presumed to act in embryonic lens induction. Although such a situation is a distinct possibility, it must still be regarded as a theory or, at most, a working hypothesis.

Before concluding, it might be well to mention evidence indicating that lens regeneration is not dependent on the location of the eye in the body, on its connection with the central nervous system by means of the optic nerve, or on its functioning as an organ of vision. Lens regeneration can occur equally well in the dark or in the light as first reported by Brachet and Benoit (1899) and by Fischel (1900), and recently confirmed by Rübsaamen (1950b). Zalokar (1944) showed that lens regeneration occurred in eyes removed from the orbit and grafted to the forehead. Reyer (unpub.) transplanted embryonic eyecups plus the developing lens anlage to the flanks of host embryos in *Triturus viridescens*. After the hosts had grown into larvae, the lens was removed from the host eye and from the graft eye now located on the belly. Lens regeneration from the iris occurred in both host and graft eyes.

4. The localization and extent of competence for lens formation in the eye

After simple lens extirpation, the new lens always regenerates from the margin of the middorsal iris. This raises intriguing problems. Morphologically, there is no great difference between the dorsal and other parts of the iris. What, then, is the cause of this localization of the potency to form a lens? When does it become fixed? Can it be changed by experimental procedures?

In 1900, Fischel proposed the explanation that gravity was the causal factor. This was quickly disproved by Wolff (1901), who raised his animals on their backs (under anesthesia or by severing the spinal cord) and still obtained lens regeneration from the morphologically dorsal iris. Later, Wachs (1920a) rotated eyes 180° in situ without cutting the optic nerve and then removed the lens. Regeneration occurred from the originally dorsal, now ventral iris. Apparently (Sato, 1933a, 1933b) this restriction of lens regeneration to the normally dorsal part of the eye takes place during embryonic development at middle tail-bud stages at the same time that the ventral location of the fetal (choroid) fissure is fixed. In this study on several hundred *Triturus taeniatus* embryos, Sato rotated the optic vesicles with overlying ectoderm 180° orthotopically at stages 21 to 32. After observing the location of the fetal fissure in the living animals, some were studied microscopically and others were raised to a late larval stage, the lens was removed, and the animals were then killed 7 days later to determine the site of lens regeneration. There are some complications in the results as to the determination of the fetal fissure. As can be seen from Fig. 11, with increasing age of the embryo at the time of operation, there was a

rapid decline in the percentage of cases which underwent complete regulation and developed a mid-ventral fetal fissure. Parallel to this, there was an increase in the percentage which self-differentiated to form a mid-dorsal fetal fissure. However, even by stage 31 to 32, there were still approximately 9 per cent in the former category and only 61 per cent in the latter. In addition, various abnormal locations of the fetal fissure were found in quite a large number of embryos. These comprised either one intermediate fissure or else two fissures, one of which was ventral and the other dorsal or intermediate. In the cases with both dorsal and ventral fissures, either the one or the other could be the larger. In spite of the presence of these deviating types and duplications, there emerged the picture of a gradual fixation of the dorso-ventral polarity of the developing eye as indicated by the location of the fetal fissure. Most of these animals were kept alive and the lens removed one to two months later; lens regeneration was found to take place, with very few exceptions, from that part of the iris opposite the fetal fissure, therefore dorsally in the regulating cases and ventrally in the self-differentiating ones. When two fetal fissures were present, the lens regenerated opposite the larger one. Apparently, the localization of the potency for lens regeneration in the iris is brought about either by the action of the fetal fissure or by an antecedent factor or factors operating similarly on both.

That this restriction of the competence for regenerating a lens can be modified experimentally has been shown by several workers. Instead of a strict localization in the mid-dorsal iris, there appears to be a gradient of lens potency, highest mid-dorsally and falling off toward either side. Several techniques have been used to obtain regeneration from other than mid-dorsal regions of the iris. Ciaccio (1933) divided the eye of *Triturus cristatus* and *T. taeniatus* adults into two chambers by means of a vertical or oblique celloidin lamina. He obtained from 1 to 5 regenerating lenses per eye. He believed that these developed from all parts of the iris margin except the mid-ventral. However, by far the largest number developed from the margin of the dorsal, dorso-nasal, or dorso-temporal portions of the iris, usually one on either side of the celloidin lamina. In further experiments, Ciaccio (1935, 1936) found that repeated removal of the dorsal iris region completely suppressed all lens regeneration. If removal of this sector was followed by placing a piece of cork in the wound (only 5 cases), then regeneration of one or two lenses from the margin of the dorso-nasal or dorso-temporal iris occurred. Similar results were obtained by Stone and Vultee (1949), using the more elegant technique of sub-

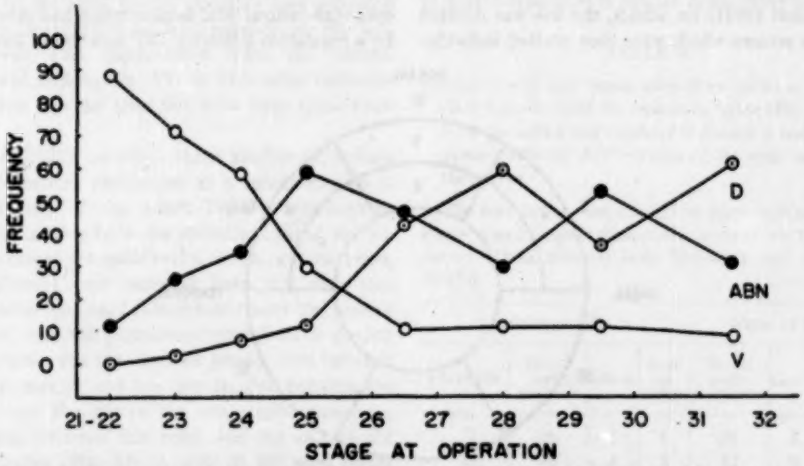

FIG. 11. PERCENTAGE OF CASES SHOWING MID-VENTRAL (V, ○), MID-DORSAL (D, ◎), AND ABNORMAL OR MULTIPLE (ABN, ●) FETAL FISSURES AFTER 180° ROTATION OF THE OPTIC VESICLE AT HARRISON STAGES 21 TO 32

(Modified from Sato, 1933a.)

stituting a piece of ventral iris for the mid-dorsal. Regeneration of two lenses from the same regions, one on each side of the grafted ventral iris, resulted.

The potency for lens regeneration is not restricted to the pupillary margin of the iris, but also extends dorsally at least as far as the ora serrata. This was shown by Okada (1935), Mikami (1941), Stone (1950a), and Stone and Vultee (1949) after inserting pieces of cornea, celluloid, or pliofilm into the dorsal iris at various locations in order to form a new free iris margin above the graft. In the experiments of these investigators, a lens regenerated from the pupillary margin of the iris in all cases and, in addition, from the free edge of the basal part of the iris above the graft as far as the ora serrata, but not from the edge of the neural retina beyond. Zalokar (1944) noticed some similar cases when the lens had been removed dorsally through the base of the iris and the wound remained open. Furthermore, in eyes originally deprived of the neural and pigmented retina, he found several examples where a lens was developing at the point of juncture of the regenerating neural and pigmented retina which had formed a sort of pseudo-"iris margin" at the opposite side of the eye from the original pupil.

These results on the iris in situ have been confirmed and extended by experiments using iris grafts. In the work of Sato (1930) on larvae and of Mikami (1941) on adults, the iris was divided into six sectors which were then grafted individually into host eyes following extirpation of the lens. Fig. 12 shows the iris sectors grafted. Sato used only complete sectors (I–VI), while Mikami divided the three dorsal sectors into distal pieces bordering the pupil (1–3) and proximal pieces at the base of the iris (4–6). Sato's results are summarized in Table 2 and those of Mikami in Table 3. Only those cases were counted as positive where lens fibers had developed in the regenerated lens. These data are in complete agreement and again demonstrate a gradient in the capacity for lens regeneration, highest at the pupillary margin of the mid-dorsal iris and declining both circumferentially around the pupil and proximally away from the pupil toward the neural retina. The iris grafts derived from the ventral half of the eye failed to regenerate lenses containing fibers, although a few examples of depigmented vesicles were noted by both authors. This has also been confirmed by Stone (1952), but differs from the results of Ciaccio (1933), already discussed, who claimed to have obtained lens regeneration from the ventral half of the iris following compartmentation of the eye. According to Mikami, the gradient in observed capacity affects not only the percentage of pieces regenerating a lens, but also the size of the lens and the degree of differentiation attained after a given interval.

A further observation by Sato (1933b) is of some interest. As previously described, he obtained eyes with ventral fetal fissures which had developed by a regulation following 180° rotation of the optic

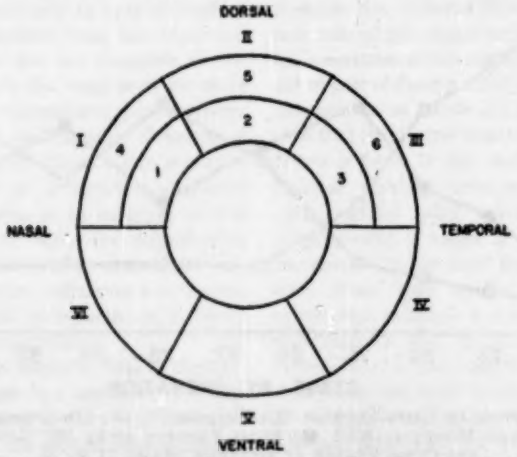

FIG. 12. DIAGRAM SHOWING THE SECTORS OF THE IRIS USED FOR IMPLANTATION INTO THE EYE CHAMBER
(Modified from Sato, 1930, and Mikami, 1941).

TABLE 2

Comparison of lens regeneration from pieces of iris derived from the six regions indicated in Fig. 12

All of the cases listed were fixed 17 or more days after the operation, except for one graft of iris region I that had regenerated a lens after only 13 days. (Data selected from Table 5, Sato, 1930).

IRIS REGION	NO. OF GRAFTS AVAILABLE	LENSES	LENS VESICLES
I	8	2	1
II	7	7	0
III	7	4	1
IV	11	0	2
V	12	0	0
VI	10	0	2

anlage in the early tail-bud embryo. After lens removal, lens regeneration in these larvae always occurred from the margin of the dorsal iris. In a series of experiments using similar animals, he tested the six iris sectors by grafting them to host eyes following lens removal as before. In spite of a large number of negative cases, shown to be due to the animals used rather than to the operation, it was clear that lens regeneration occurred most frequently from the mid-dorsal piece, originally the mid-ventral in the embryo before rotation of the optic vesicle (Table 4). Apparently the reversal of polarity indicated by the "neighborwise" development of the fetal fissure ventrally also extended to the distribution of lens potency in the iris. However, lens regeneration from the ventrotemporal region, No. IV, in two cases indicates that this reversal may not have been quite complete.

Sato (1951) extended these studies to include the pigmented epithelium in a mid-dorsal meridional strip of the adult *Triturus pyrrhogaster* eyeball running from the dorsal margin of the iris to the exit of the optic nerve. Sclera, neural retina, and choroid were removed from this area (the last mentioned only incompletely near the base of the iris) and the pigmented epithelium of the iris and retina was cut into six pieces, two between the iris margin and ora serrata, two between the latter and the exit of the vena bulbi superioris, and two between this point and the exit of the optic nerve (Fig. 13). A total of 239 such pieces of pigmented epithelium were implanted separately into host eyes of the same species immediately after extirpation of the lens. The results observed 17 to 30 days after the operation are summarized

TABLE 3

Comparison of lens regeneration from pieces of iris derived from the nine regions indicated in Fig. 12

Relative size defined as in Table 1. Some of these cases were fixed 20 days after the operation, while these data were not given for the remainder. (Data selected from Tables 1 and 2, Mikami, 1941).

IRIS REGION	NO. OF GRAFTS AVAILABLE	NO. LENSES REGEN.	PERCENTAGE OF LENS REGEN.	NO. OF CASES MEASURED	MEAN RELATIVE SIZE OF REGEN. LENS
1	28	21	75	14	0.56
2	19	16	84	11	0.71
3	16	9	56	6	0.40
4	26	13	50	9	0.45
5	17	13	76	9	0.59
6	20	3	15	3	0.34
IV	16	0	0		
V	19	0	0		
VI	16	0	0		

in Table 5. It can be seen that the percentage of implants regenerating a lens dropped rapidly from the iris margin to the ora serrata, but that nearly one-quarter of the grafts of the pigmented layer of the retina still regenerated a lens. Some of the negative cases exhibited different degrees of depigmentation, while in others the grafts were broken up into clumps of pigmented cells. These results are in contrast to those of Stone (1950c), in whose experiments similar intraocular grafts of

TABLE 4

Comparison of lens regeneration from pieces of iris derived from the same six regions as before (Fig. 12) *but from eyes which had regulated to develop a ventral fetal fissure following 180° rotation of the optic vesicle in the embryo*

The host larvae were fixed 17 or more days after lens removal and implantation of the piece of iris from the donor. (Data selected from Tables 5 and 6, Sato, 1933b).

	SERIES OF 1930			SERIES OF 1932		
Iris region	No. of grafts available	Lenses	Lens vesicles	No. of grafts available	Lenses	Lens vesicles
I	26	1	1	28	2	1
II	26	4	2	32	9	3
III	22	0	1	30	4	1
IV	22	1	0	25	1	0
V	22	0	1	25	0	1
VI	21	0	0	24	0	0

pigmented retinal epithelium, together with choroid and sclera, regenerated new neural retina but never any lenses. A possible explanation of these striking differences might lie in the influence of the adhering choroid and sclera, which somehow caused the pigmented epithelium to produce neural retina instead of a lens. This remarkable capacity of the pigmented retinal epithelium to produce not only more of its own type of tissue, but also neural retina and even lens should provide a fruitful subject for further research.

layers of the neural retina. These were found subsequent to lens extirpation and culture of the animals for varying lengths of time. The appearance of these retinal "lentoids" is not limited to species known to regenerate a lens, such as *Triturus viridescens* larvae (Reyer, 1948) and *Salamandra salamandra* larvae (Fischel, 1900, 1903, 1921), but has also been reported in species where the capacity for lens replacement is somewhat doubtful or very unlikely, viz., *Hynobius unnangzo* (Ikeda, 1935, 1936b, 1937), *Rana catesbiana* (Pasquini,

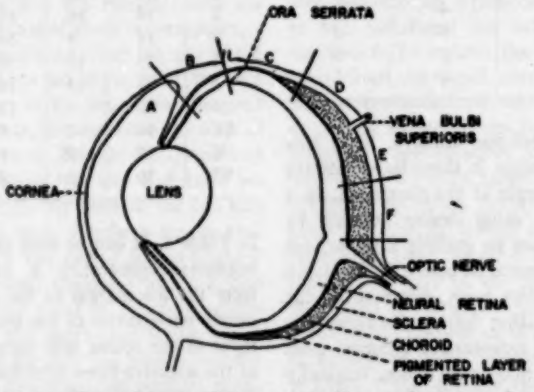

FIG. 13. DIAGRAM OF A CROSS-SECTION THROUGH THE EYE TO SHOW THE AREAS OF IRIS AND PIGMENTED LAYER OF THE RETINA REMOVED FOR IMPLANTATION INTO THE EYE CHAMBER (Modified from Sato, 1951).

The last area to be considered in this survey of the extent of lens competence in the *Triturus* eye is the neural retina itself. Here, no final conclusion can be reached at this time. Several authors have described irregular masses of lens tissue, with or without epithelium, embedded in the surface

TABLE 5

Comparison of lens regeneration from pieces of the iris and pigmented layer of the retina derived from a dorsal meridional strip of the eyeball, as shown in Fig. 13

(Data selected from Tables a to f, Sato, 1951).

AREA	NO. OF GRAFTS AVAILABLE	LENSES		LENS VESICLES NO.
		No.	%	
A	42	39	93	1
B	46	25	54	3
C	41	9	22	8
D	38	9	24	2
E	37	9	24	5
F	35	4	11	1

1932), *Amblystoma mexicanum* (Törö, 1932), and *Amblystoma punctatum* (Stone and Dinnean, 1940). Fischel, Ikeda, and Törö concluded that these lentoids developed by a direct transformation of neural retinal cells into lens fibers. The single case in *Rana catesbiana* occurred after transplantation of the optic vesicle in the embryo. Pasquini did not eliminate the above hypothesis but favored an origin from a fragment of ectoderm pressed into the transplant. In Stone and Dinnean's experiments on *Amblystoma punctatum*, good evidence was obtained for the development of the lentoids from fragments of the old lens embedded in the surface of the retina. A similar explanation was proposed by Reyer (1948) for the *Triturus viridescens* larvae. However, in the latter study, several cases were observed where the lentoid, although partly embedded in the retina, was attached to the margin of the dorsal iris by its epithelium. Either a secondary fusion between lentoid and iris had occurred here, or else the lentoid had regenerated from the iris and subsequently become

pressed into the surface of the thickened retina, as figured in one specimen by Adelmann (1928).

5. Polarity of the regenerating lens

During the embryonic development of the lens, the mediolateral axis is first marked morphologically by the differentiation of lens fibers from the medial pole of the lens vesicle, while the lateral pole remains as the lens epithelium. A similar series of events takes place during lens regeneration, so that the fiber pole of the regenerating lens always faces medially, even though dorsal bending may occur in the early stages.

A logical assumption is that fiber formation from the side of the lens vesicle facing the retina is brought about by the action of this tissue. There is, however, little direct evidence in support of this. Reyer (1948) noticed that, in lentoids possessing an epithelium, the fiber pole was always embedded in the retina with the epithelium projecting beyond the retinal surface into the vitreous chamber, whereas lentoids completely surrounded by retina were composed entirely of fibers and lacked epithelium. Mikami (1941), when studying lenses developed from iris grafts, made essentially opposite observations, namely, that when grafts were in contact with the retina, the fiber pole of the lens faced away from the retina.

It is obvious that this phase of lens regeneration must be studied more thoroughly before any conclusions can be reached. A comparison of the fixation of the mediolateral axis of the lens during embryonic development and during regeneration would be of interest, if technically feasible.

6. Miscellaneous observations

The *Triturus* eye is not only capable of replacing a lost lens by regeneration from the dorsal iris, but this process can be repeated, at least up to seven times (Ciaccio, 1934; Nikitenko, 1939a). Stone and Farthing (1942) were also able to obtain the regeneration of both the lens and neural retina after transplanting the same eye four times. Formation of a new lens and return of vision was observed after each transplantation.

The role of the endocrine system in lens regeneration has been studied by relatively few investigators. Lenhard (1928) observed the inhibition of lens development in only 3 out of 42 cases after removing the thyroid gland; Nikitenko (1940) failed to find any clear-cut retardation following hypophysectomy. Schotté and Murphy (1953) also reported that there was no specific effect of the hypophysis on the regeneration of the lens. In their experiments on adult *Triturus viridescens*, the hypophysis and the lenses of both eyes were removed in a single operation. All hypophysectomies were verified histologically. The course of lens regeneration was then studied in the eyes of 20 hypophysectomized animals and of 15 control animals (lens extirpation only) kept together at a constant temperature of 20 ± 1°C. and fixed 15 to 33 days after the operation. Typical stages in the development of a lens from the margin of the dorsal iris were observed in the hypophysectomized animals. However, the rate of lens differentiation was delayed from 3 to 5 days as compared to that in the control animals. The authors believe this to be due to the general deleterious effect of hypophysectomy on the whole animal rather than to a specific inhibition of lens development. They are of the opinion that Lenhard's (1928) experiments on lens regeneration after thyroidectomy indicate that this process is also independent of thyroid secretion, although this is contrary to Lenhard's own interpretation of his results (see the paper of Schotté and Murphy for a further discussion).

B. Experiments on embryos

The comparison of development in the embryo with regeneration in later life has long occupied the attention of embryologists. In the case of lens regeneration, the known capacity of the optic vesicle to induce a lens from competent foreign ectoderm led Spemann (1905) to conceive of an enduring capacity for lens induction that was first an attribute of the optic vesicle and was then retained by its derivative, the neural retina, throughout the life of the animal. This activity of the retina, then, would be the factor responsible for initiating lens regeneration from the iris. We have already discussed evidence for the operation of such an agent in larval and adult eyes. However, its relation, if any, to the embryonic lens inductor is obscure. It would seem that one way to obtain data bearing on this question would be to study lens formation from the iris in as early a stage in the development of the embryo as possible. These experiments should furnish answers to questions such as these: What is the earliest developmental stage at which lens formation from the eyecup margin can occur? Will a lens develop from the eyecup or iris margin if its development from the

ectoderm has been prevented? If so, at how early a stage? Is there any difference in the morphological pattern, or in the rate of differentiation during lens regeneration in embryonic as compared with larval eyes?

The first example of Wolffian lens regeneration following removal of the lens in the embryo was reported by Spemann (1905) for *Triturus taeniatus*. Using embryos corresponding approximately to Harrison's stages 32 to 34, he removed the ectoderm overlying the optic cup and the attached lens plug together with some of the distal optic cup. The surrounding head ectoderm was allowed to heal over the wound. There was one case, fixed after 7 days, in which no lens was induced from the regenerated head ectoderm due to the presence of a layer of mesenchyme between the eye and this tissue. Attached to the margin of the dorsal iris in this eye was a small, depigmented epithelial vesicle identical in appearance with an early stage in lens regeneration.

Reyer (1948) performed a large number of similar experiments, comprising age group A (stage 34 to 36) in his experiments on *Triturus viridescens* (p. 7). During the removal of the lens plug, care was taken to injure the optic cup as little as possible. There was no lens induction from the regenerated head ectoderm. Forty-six examples, representing all stages of lens regeneration, were obtained from the 132 eyes. However, it was noted that, among the animals killed on any particular day, there was a large amount of variability in the stage of regeneration attained. In addition, lens regeneration failed to occur in a number of instances long after it had begun in most of the eyes (Fig. 14). It was possible to correlate, to some extent, the failure or retardation of lens formation with the condition of the eye. In general, eyes with a well-formed iris and adequate vitreous chamber regenerated a lens best, while eyes with a poorly formed iris, a small or absent vitreous chamber, and thick, bulging retina either failed to develop a lens at all or were retarded in this process.

Experiments in which lens formation from the iris was observed following a probable failure of lens induction from the ectoderm were first reported by Adelmann (1928). Using *Triturus taeniatus* embryos, he removed a circular piece from the prospective eye region of the neural plate together with the underlying mesoderm and grafted it to the flank of an early head and tail-

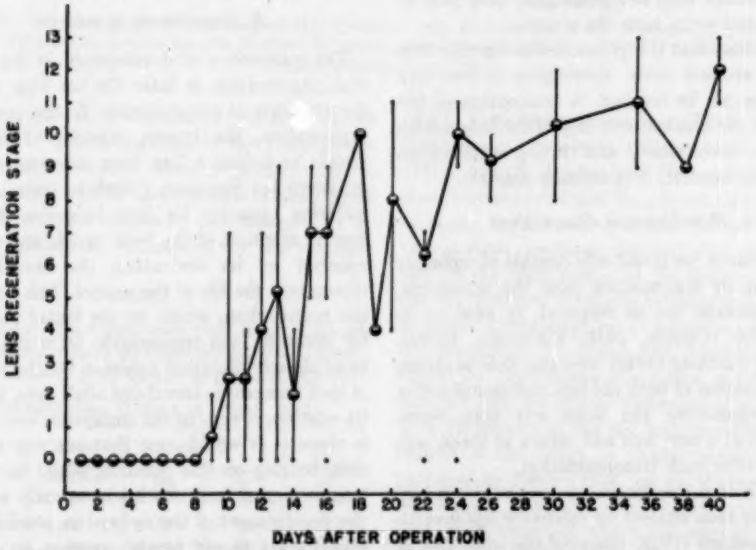

FIG. 14. RATE OF LENS REGENERATION FOLLOWING REMOVAL OF THE LENS PLUG FROM THE EYES OF TRITURUS VIRIDESCENS EMBRYOS OF AGE GROUP A

See p. 7. Half-open circles mark the average lens regeneration stage; small dots, the extreme stages for each day. Cases exhibiting no lens regeneration 16 or more days after the operation were not included in the averages. (From Reyer, 1948, reproduced by courtesy of the *J. exp. Zool.* and the Wistar Institute).

bud host oriented so that the eye would develop with the pupil facing inwards. Among the 19 successful cases in which the pupil faced away from the surface ectoderm, there were four (fixed after 26 to 56 days) in which lens development from the iris appeared to be initiated. These consisted of (1) a depigmented iris margin identical with stage 3 of lens regeneration, (2) a much thickened iris with depigmented margin, (3) a lentoid with lens fiber pole embedded in the retina and attached by epithelium to the margin of the iris, and (4) a depigmented vesicle connected to the junction of iris and retina. A complicating factor in these results was the presence of large extra-ocular lenses or lentoids of unknown origin in the first, third, and fourth cases. Also, only one example showed a structure typical of lens regeneration from the iris, the others being more or less abnormal. Woerdeman (1939a) mentioned similar results among experiments on lens induction where the optic vesicle had been grafted into the abdominal wall. Lens induction from the ectoderm and lens formation from the iris were frequently observed in the same eye, but no details were presented.

In a further analysis of this question on over one hundred *Triturus viridescens* embryos, Reyer (1950) blocked the development of the embryonic lens by replacing the prospective lens-forming ectoderm of the host *Triturus* (neurula or early head and tail-bud stage) with prospective belly ectoderm from an *Amblystoma punctatum* donor (late neurula or early head and tail-bud stage, 18 to 24). Animals were killed for microscopic study daily from 1 to 40 days after the operation. As in the case of similar homoplastic grafts in *Amblystoma punctatum* (Harrison, 1920; Stone and Dinnean, 1940), lens induction failed to occur from the *Amblystoma* belly ectoderm.

In the cases where the host eye was completely covered by the graft ectoderm, 13 were found containing an epithelial vesicle or lens, in 55 there was no trace of lens tissue, 21 showed various stages of lens formation from the dorsal iris, and 7 contained retinal lentoids. From the study of a control series where some of the inner layer of the prospective lens ectoderm was intentionally left adhering to the optic vesicle, it appeared that this was probably the origin of the vesicles and lenses in the above 13 cases, and perhaps also of some or all of the retinal lentoids, which were similar to those cases, previously described which were found after removal of the lens in young larvae. Lens development from the dorsal iris was typical and included stages from 2 to 11. As in the experiments where the lens plug was removed from the

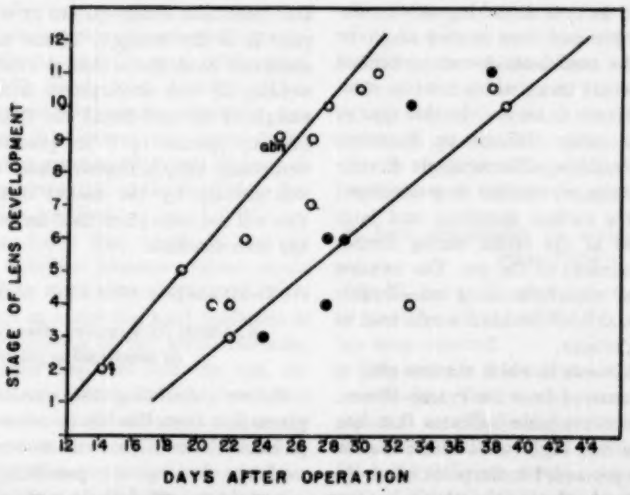

FIG. 15. LENS DEVELOPMENT FROM THE DORSAL IRIS IN THE ABSENCE OF THE EMBRYONIC LENS

Stage of differentiation plotted against days after operation. The clear and dark circles mark the individual cases for two series of experiments, while the lines indicate the boundaries within which all of the normal cases fall except for those showing marked retardation. ?, a doubtful case; *abn.*, a somewhat abnormal lens. (From Reyer, 1950, reproduced by courtesy of the *J. exp. Zool.* and the Wistar Institute.)

embryonic eyecup, there was considerable variation among the different specimens in the number of days following the operation required to attain a particular stage in lens differentiation (Fig. 15; see also Reyer, 1950, Figs. 18–26).

These results were confirmed by additional experiments of the same type (Reyer, 1954), in which both the *Amblystoma* donor and *Triturus* host were in a neural plate stage (13½ to 15). With a properly placed graft, lens development from the surface ectoderm was prevented in all cases. In 9 out of these 31 animals, lens formation from the dorsal iris occurred.

Lens development from both the dorsal and ventral iris, as well as from the retina, was reported in *Triturus alpestris* embryos by Dürken-Woitzik (1950), following destruction of the prospective lens ectoderm by ultraviolet radiation. However, these results were complicated by the uncertainty of complete destruction of all of these cells capable of lens formation. Her criteria for lens differentiation from the iris do not appear to be adequate, and no typical cases of such a process were illustrated.

Rübsaamen (1949, 1950a) described the appearance of retinal lentoids in the absence of a normal lens after culture of *Triturus alpestris* and *T. taeniatus* embryos under conditions of oxygen deficiency (2.1% O_2: 97.9% N_2 atmosphere). These were found in eyes exhibiting varying degrees of abnormality and even in two acephalic embryos, where the small lentoids were embedded in disorganized neural tissue which bore no morphological resemblance to an eye. In this type of experiment, it is rather difficult to determine whether these lentoids differentiated directly from the neural retina, or whether they developed normally from the surface ectoderm and later became embedded in the retina during further abnormal morphogenesis of the eye. The location of some of these structures at a considerable distance from the skin of the head would tend to favor the first hypothesis.

From the experiments in which the lens plug or young lens was removed from the eyecup (Reyer, 1948), the evidence available indicates that lens regeneration does not begin until differentiation of the eyecup has proceeded to the point where the outer layer of the developing dorsal iris is completely pigmented. Taking regeneration stage two as the first clear indication of lens formation, the youngest animal in which this condition was observed had reached developmental stage 41 (notched forelimb buds) 4 days after removal of the young lens at stage 38 (age group B) (Reyer, 1948, Figs. 12, 37, 38). When the developing lens was removed earlier, in the lens plug condition (age group A), the first appearance of lens regeneration was not observed until 9 days after the operation at developmental stage 44.

A somewhat unexpected result was found after blocking lens development in the embryo (Reyer, 1950, 1954). Here, lens formation from the dorsal iris was not observed until 19 or more days had elapsed after the operation, at which time the larvae were feeding and beginning to develop a hind-limb. In the animal killed after 19 days, a lens of stage 5 was developing from the dorsal iris. Since it would have required about three days for such a lens to develop from stage 2 to stage 5, the first visible change in the iris would have been present 16 days following the operation at a developmental stage of approximately 46.

These results indicate that normal lens formation from the dorsal iris will take place in an eye that has developed in the complete absence of the embryonic lens. In these cases, operative injury has played no role in initiating lens formation, nor has the earlier presence of a lens in the eye been a necessary factor. It can be concluded that the *Triturus* eye possesses two mechanisms of lens formation which operate at widely separated periods in the ontogeny of the animal: (1) lens induction from the ectoderm overlying the optic vesicle; (2) lens development from the pupillary margin of the mid-dorsal iris. If the first method fails to operate or if its product, the normal embryonic lens, is removed later on, then a lens will develop by the second method. However, this will not take place until an early larval stage has been attained.

IV. REGENERATION OF A LENS IN OTHER AMPHIBIA

A. Lenses from sources other than the iris as complicating factors

Before considering the question of lens regeneration from the iris in other species of amphibians, it would be well to review briefly the evidence showing the possibilty, following attempted removal of the lens, of lens development from sources other than the dorsal iris. If the prospective lens ectoderm is removed in the embryo, and the optic vesicle is either covered by

some tissue unable to form a lens or else is excised and grafted to some site removed from any tissues competent for lens formation, the mere presence of lenses in the eyecup later on in development is insufficient evidence for assuming that Wolffian regeneration has occurred. If the graft fails to cover the optic vesicle completely, a lens can develop, in most species, from the surrounding head ectoderm after it has healed over the eye. Failure to remove completely all of the prospective lens ectoderm is another possible source more difficult to diagnose. This is especially likely to occur in later tail-bud stages, when this ectoderm and the optic vesicle adhere very tightly together (Stone and Dinnean, 1940). However, it can also occur in early optic vesicle stages, at least in *Triturus viridescens* and *Rana esculenta*, due to a tendency for the outer layer of ectoderm to peel off in a continuous sheet and leave all or parts of the inner layer adhering to the surface of the optic vesicle and indistinguishable from it in the living embryo (Spemann, 1912; Reyer, 1950).

When the lens is removed from the eye in late embryonic and early larval stages, it is very soft and easily fragmented. Such fragments, containing lens epithelium, are capable of regenerating new lens fibers and, in many instances, of reconstituting a new normal-appearing lens. Similar results can be obtained, following complete lens removal, if pieces of the lens are then reimplanted into the eye chamber (Stone and Dinnean, 1940; Stone and Sapir, 1940; Ikeda and Amatatu, 1941; Reyer, 1948). Lens fragments containing lens epithelium from older larvae also have similar capacities in most species. However, at least in the urodeles, fragmentation of the firm, older lens during removal is less likely.

Ikeda (1934a) found that pieces of lens epithelium from *Hynobius unnangso* larvae would develop lens fibers even when implanted into a foreign site, such as under the head epidermis or into the fourth ventricle of the brain. However, contrary to similar implants into the eye, degenerative changes always ensued after more than 14 days in the abnormal location. It would appear that the lens is much more resistant to injury and is much better able to reorganize a new lens from fragments of the old in some species, such as *Hynobius unnangso*, than in others. *Triturus* seems to have the least capacity in this respect (Ikeda and Amatatu, 1941; Ikeda, 1943). Reimplanted fragments of the lens always degenerated in adult *Triturus viridescens* (Stone and Sapir, 1940), and Ikeda and Amatatu (1941) reported that lenses injured in situ or during reimplantation went to pieces in larvae of *Triturus pyrrhogaster*. The sensitivity of the lens to injury in a species known to regenerate a lens so readily from the iris is of considerable interest. From the evidence of Stone and Sapir (1940) and Okada (1939, 1943a, b), it would appear that not only are the lenses of tadpoles and adult anurans very subject to fragmentation during removal, but also the lens epithelium in these forms has a high capacity for the development of new lens fibers.

Since the possibility of lens development from other sources must be taken into account, how can one be reasonably certain that lens regeneration from the dorsal iris is occurring in some particular species under study? It would seem that the safest approach would be (1) by careful operative technique, to reduce the sources of lens tissue from lens fragments, incompletely removed prospective lens ectoderm, etc., to a minimum; (2) by killing the specimens daily over a period of several weeks, to obtain a complete series of stages showing the details of the regenerative process corresponding in stage of development, with allowance for variability, to the time elapsed since the operation. Obviously, the early stages should be connected to their source of origin, viz., the dorsal iris. These criteria can be applied readily to a species where regeneration occurs with great regularity, as in *Triturus*. Difficulty arises, however, when it is suspected that the species in question may show lens regeneration in only a small percentage of cases. This will be brought out in the ensuing discussion.

B. Lens regeneration in urodeles other than the genus Triturus

In Table 6 are listed the other genera and species of urodeles in which Wolffian lens regeneration has been reported.

The evidence is conclusive only for *Salamandra salamandra*. This species was one of the first reported as able to regenerate a lens from the dorsal iris (Fischel, 1900, 1903; Reinke, 1906). Fischel and Reinke found a much slower rate of regeneration for this form than that found in *Triturus*. If numbers from the Sato stage series are assigned to the examples figured in their illustrations, stage 1 was found 14 days after lens extirpation, stage 4 after 36 days, stage 7

TABLE 6

Lens regeneration in urodeles other than Triturus

SPECIES	AGE*	RESULT	AUTHOR
Amblystoma punctatum	embryos (19–22)	positive	Beckwith, 1927
Amblystoma punctatum	embryos and young larvae (21–46)	negative	Stone and Dinnean, 1940
Amblystoma punctatum	older larvae (25 mm.)	negative	Stone and Sapir, 1940
Amblystoma punctatum	embryos (14)	positive	Sperling, 1943
Amblystoma mexicanum (axolotl)	embryos and larvae	positive	Törö, 1932
Amblystoma mexicanum (axolotl)	embryos	negative	Manuilowa and Kislow, 1934
Amblystoma mexicanum (axolotl)	larvae	positive	Pasquini and Della Monica, 1929
Amblystoma mexicanum (axolotl)	larvae	negative	Stone (unpub.)
Amblystoma mexicanum (axolotl)	larvae (4 cases only)	negative	Wachs, 1914
Amblystoma tigrinum	larvae (23–70 mm.)	negative	Stone and Sapir, 1940
Hynobius unnangso	embryos	positive	Ikeda, 1936b, 1937
Hynobius unnangso	larvae	negative	Ikeda, 1934b, 1936b
Pleurodeles waltl (=*waltlii*)	embryos	rarely positive	Pasquini, 1927
Salamandra salamandra (=*maculosa*)	larvae	positive	Fischel, 1900, 1903; Reinke, 1906; Sato, 1930; Politzer, 1930; Ciaccio, 1934; Reyer and Stone, 1951
Salamandra salamandra (=*maculosa*)	adult	positive	Stone (unpub.)
Salamandrina ter-digitata (=*perspicillata*)	larvae	positive	Wachs, 1914

* Refers to the age at the time of the operation. Numbers in parentheses indicate the stages in the Harrison series for *Amblystoma punctatum* or the length in mm. of older larvae.

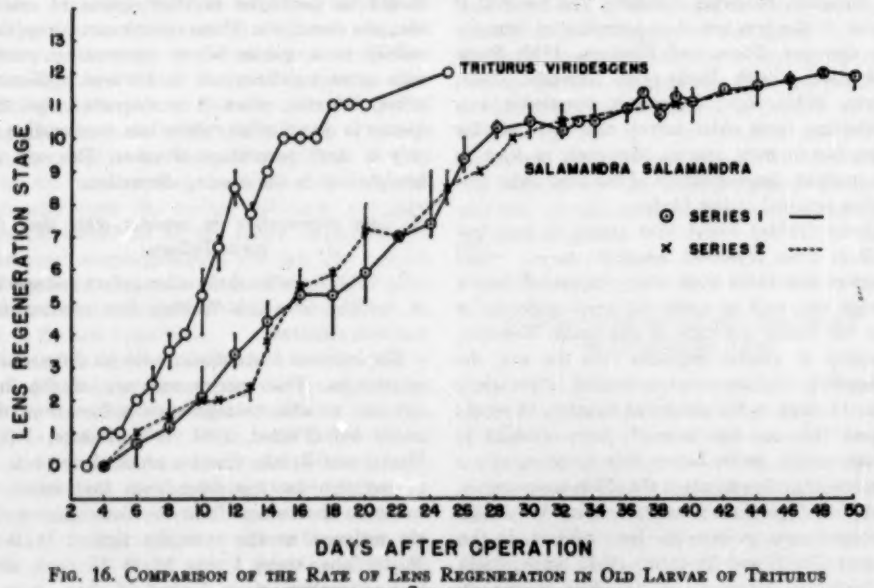

FIG. 16. COMPARISON OF THE RATE OF LENS REGENERATION IN OLD LARVAE OF TRITURUS VIRIDESCENS AND SALAMANDRA SALAMANDRA

⊙, experiments of Reyer; ×, experiments of Stone. (From Reyer and Stone, unpub.).

after 54 to 56 days, stage 10 after 73 days, and stage 12 after 148 days. Including a photograph by Politzer (1930), a total of 9 normally regenerating lenses still attached to the margin of the dorsal iris were illustrated by these authors. Most of Fischel's numerous figures depicted older lenses, abnormal types of lens regeneration following injury, and retinal lentoids.

In a reinvestigation of this question, Reyer and Stone (1951) followed the course of lens regeneration in over 200 larvae killed at one- or two-day intervals over a period of 50 days. The results are shown in Fig. 16. A complete series of regeneration stages was obtained. It can be seen that regeneration has occurred at a rate about one-half that found in *Triturus viridescens* larvae but still much faster than in the experiments of Fischel et al. There were a few minor differences between the histogenesis of the regenerating lens in *Salamandra* and *Triturus*. In *Salamandra*, the regenerating lens originated from the margin of the temporo-dorsal rather than mid-dorsal iris as in *Triturus*; depigmentation took place more gradually so that the lens was never entirely free of pigment granules, and the cells from the wall of the vesicle usually folded into the lumen and obliterated the cavity. No lentoids or abnormal regenerating lenses were observed.

In his work on *Salamandra*, Fischel was the first to attempt an experimental analysis of the causal factors involved. His studies, though often not conclusive, pointed the way for later attacks on the same problems. In studying the localization of competence for lens formation, he removed part of the dorsal iris and observed attempts at lens regeneration from the inner lamina of the iris close to the base. Since retinal lentoids had also appeared quite frequently, he concluded that not only the margin of the dorsal iris, but also the rest of the dorsal pars iridica retinae, pars ciliaris retinae, and pars optica retinae are capable of differentiating into lenses or lentoids. On the basis of experiments in which lens regeneration took place following the implantation of pieces of potato, bread, or cornea into the eye, he concluded that the space left after lens removal was not the initial releasing factor for lens regeneration, but only a secondary factor which could affect the course of regeneration and result in distortion of the developing lens when insufficient room was available. As mentioned previously, he proposed an injury stimulus as the factor releasing lens regeneration, a theory that has since been disproven.

Sato (1930) reported a preliminary study in which lens regeneration in *Salamandra* was found to proceed more rapidly following bilateral lens extirpation than following a unilateral operation. An even greater acceleration of lens regeneration from the host *Salamandra* iris appeared to occur after the implantation of a piece of iris either from *Salamandra* or *Triturus*. These results are of great interest, but are based on too few cases for one to draw any definite conclusions regarding factors controlling the rate of lens regeneration in *Salamandra*.

Wachs (1914) reported lens regeneration in larvae of *Salamandrina ter-digitata* (= *perspicillata*), but figured only 4 cases showing regeneration stages 3 and 10 to 11 in animals killed 14 and 22 to 25 days after the operation. Attachment to the dorsal iris is clear in the photograph of the stage 3 regenerate and appears probable in one of the others. From this rather scanty evidence, it would appear that Wolffian lens regeneration also occurs in this species.

In spite of an intensive study by Ikeda (1934b, 1936b, 1937) on over 1700 cases, the situation in the Japanese species *Hynobius unnangso* is still uncertain. Ikeda (1934b) failed to obtain any in-

TABLE 7

Stages in eye development used in the studies on lens regeneration in Hynobius unnangso embryos

For details, see text. (Adapted from Ikeda, 1936b, 1937, 1939).

STAGE NO.	APPEARANCE OF EYE AND LENS
1	neural folds, eye plate
2	neural folds closing, eye pouch
3	tail-bud, primary optic vesicle
4	primary optic vesicle with thickened distal wall
5	eyecup with lens placode
6	eyecup with lens plug
7	lens vesicle still attached to overlying ectoderm
8	detaching lens vesicle
9	lens vesicle with thickened inner wall
10	lens with beginning lens fibers
11	lens with a well developed primary lens fiber pole
12	primary lens fiber pole completed
13	layers just appearing in retina
	General appearance of larva
14	almost complete gills; lanceolate forelimb-buds
15	mouth opened, hatched

dication of lens regeneration after removal of the lens in late embryos, larvae, or adults (from a stage with early forelimb-buds to sexual maturity). In the earliest stage used, the primary fiber pole had been completed and almost filled the lumen of the lens. Studies on five other species of this genus yielded similar results (Ikeda, 1938b). However, when the developing lens was removed from 487 eyes in younger stages beginning with the lens placode (Table 7, stages 5 to 12), Ikeda (1936b) reported lens formation from the dorsal iris in 4 to 9 per cent of those animals from which a lens had been removed as a late lens plug up to a lens vesicle with beginning lens fibers (stages 7 to 10). Lens development from the head ectoderm that healed over the eye was also found, but decreased from 100 per cent when the lens placode was removed to 4 per cent at stage 10. The latter results will be discussed in Section V. In order to eliminate any inhibitory action due to these lenses formed from head ectoderm, Ikeda (1937) removed the prospective lens ectoderm or developing lens from 339 embryos at the beginning neural fold stage up to the forelimb-bud stage (stages 1 to 10) and then implanted the optic anlage (plate, vesicle, or cup) either into the head mesoderm of a host embryo or into the fourth brain ventricle of a larva. The animals were fixed successively up to 28 days after the operation. In these experiments, he reported a much higher percentage of lens regeneration, up to 50 per cent when the primary optic vesicle was transplanted, and decreasing to 2 per cent when the oldest eyecups were implanted. No such lens formation was found when the optic anlage was removed from donors before closure of the neural folds. In addition to lens regeneration from the dorsal iris, numerous lentoids were found associated with the neural retina and tapetum oculi. These results are shown in Fig. 17. Ikeda concluded that lens regeneration from the iris in this species is limited to a short period during embryonic life, a period which begins after the optic vesicle has come into contact with the prospective lens-forming ectoderm and extends, with decreasing frequency, to the stage when the lens has begun lens fiber differentiation.

Several lines of evidence would seem to indicate

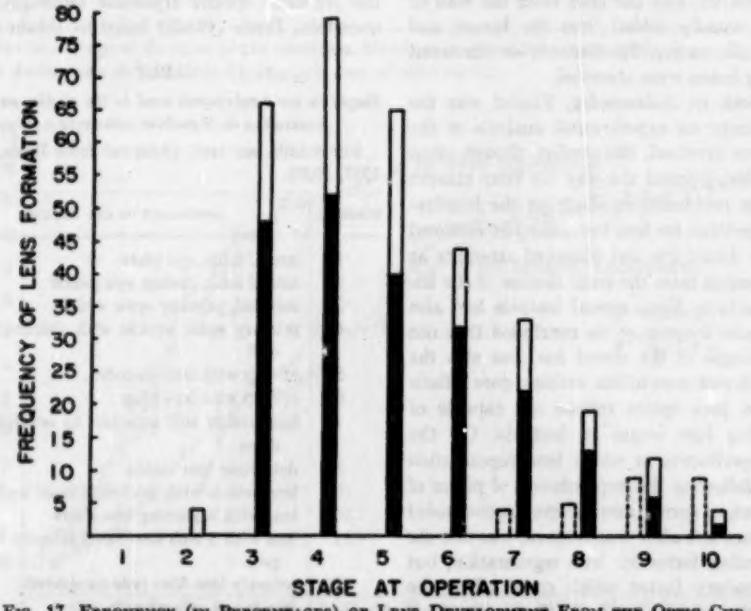

FIG. 17. FREQUENCY (IN PERCENTAGES) OF LENS DEVELOPMENT FROM THE OPTIC CUP IN EMBRYOS OF HYNOBIUS UNNANGSO

Columns bounded by broken lines give the results from the experiments on the eyes in situ, those bounded by solid lines from the experiments on the transplanted eyes. In the latter, the black portions represent lens formation from the iris margin, the clear portions, lens formation from other parts of the eyecup. Along the abscissa are plotted the stages at the time of operation in terms of the numbers presented in Table 7. (Modified from Ikeda, 1937).

that at least part of the lenses observed here developed from fragments of the old lens or from prospective lens ectoderm left adhering to the grafted optic vesicle, notwithstanding the author's statement (Ikeda, 1937, p. 46) that: "Hervorzuheben ist, dass das Transplantat dabei keine Spur von unterliegendem Entomesoderm und von überziehender Epidermis besass." The embryonic stages in which lens regeneration occurred are those in which the optic vesicle and lens-forming ectoderm adhere to one another, or in which the developing lens is soft and easily fragmented. In the experiments on the eye in situ, the author mentioned the occurrence of lens development from fragments of the old lens and the presence of lentoids in the retina, without giving number or details. In the experiments involving transplantation of the eye, lenses were found in the neural retina or next to the tapetum oculi somewhat less than one-half as frequently as next to the pupillary margin of the eyecup. In neither paper did Ikeda present a graded series of stages of lens regeneration correlated with the duration of time since the operation. As depicted in his photographs, the eyes which were selected as examples of early stages in the regeneration of a lens showed only a thickened pupillary margin; the stages with young lens fibers were rather atypical, were found only 5, 7, or 10 days after the operation, and were either detached from the iris or fused to it, but without that continuity of lens cells with those of the iris laminae which is usually characteristic of this period in lens regeneration. Also figured were large detached lenses, frequently with somewhat irregular fibers, fixed only 14 to 17 days following the operation. However, there is one case, illustrated in the 1936b paper, in which the lens had been removed at the stage when the lens fibers were first appearing (stage 10, Table 7). Eighteen days later a typical regenerating lens of Sato stage 7 was found attached to the dorsal iris (Fig. 18). Therefore, out of more than 1700 operations on embryos, larvae, and young adults of this species, Ikeda has figured only a single example which appears to be a typical case of lens regeneration from the dorsal iris. How many others were also found cannot be ascertained, since it would appear quite possible that many of the developing lenses, listed by Ikeda as having regenerated from the dorsal iris, actually developed from lens fragments or prospective lens ectoderm.

The evidence for *Amblystoma punctatum* is conflicting. Sperling (1943) described cases where various extra lenses were found in association with partially cyclopic eyes resulting from operative removal of the anterior roof of the archenteron at the neurula stage. Although the author believes that some of these developed from the retina or from the pupillary margin of the dorsal eyecup, there are no figures that show a lens attached to the dorsal iris. Furthermore, Stone and Dinnean (1943), after similar operations, observed only a single lens associated with each pupil in partial cyclopia or with the single median eye in complete cyclopia.

Beckwith (1927) blocked lens formation in 92 embryos of stage 19 to 22 by substituting, for the prospective lens ectoderm, flank or branchial ectoderm incompetent for forming a lens. She stated that a lens developed from the pupillary margin of the dorsal eyecup in 24 out of 98 cases, killed at stages 38 to 46. In 14 of the animals, the lens was reported as still attached to the margin of the dorsal iris, while in 10 it was not so attached. However, of the examples figured in her drawings, two resembled folds of the retina rather than a beginning of lens formation. Among those showing characteristic lens structure, only two were attached to the margin of the dorsal iris. One of these appears to have been a regenerating lens of stage 7 (Fig. 19), while the other was an older lens with well differentiated lens fibers pressed into the surface of the retina, and with a somewhat doubtful connection between lens epithelium and outer iris lamina.

Stone and Dinnean (1940) repeated these experi-

FIG. 18. LENS REGENERATION STAGE 7 IN AN EYE OF HYNOBIUS UNNANGSO, 18 DAYS AFTER REMOVAL OF THE YOUNG LENS FROM THE EMBRYONIC EYECUP

C, cornea; DI, dorsal iris; LE, lens epithelium; LF, lens fibers. (Drawn and modified from photograph in Ikeda, 1936b).

ments in addition to removing the developing lens from a graded series of older embryos up to stage 46. No evidence was obtained for lens formation from the dorsal iris in any of these 330 animals, although lens tissue was found in 39 per cent of the cases. In the younger embryos used (stage 21–32), this apparently developed either from incompletely removed prospective lens ectoderm or else from the surrounding head ectoderm which was allowed to heal over the optic vesicle in some of the experiments; in older embryos (stage 33–46), incompletely removed fragments of the developing lens appeared to be the source. When the lens was removed from older larvae (25 mm. long), there was no indication of lens regeneration, and lens tissue was entirely absent from the eyes 20 to 46 days later (Stone and Sapir, 1940). Similar results were obtained for larvae of *Amblystoma tigrinum* (Stone and Sapir, 1940) and *Amblystoma mexicanum* (Stone, unpub.).

Törö (1932) also performed experiments on *Amblystoma mexicanum* similar to those of Stone and Dinnean on *A. punctatum*. He reported lens induction from the head ectoderm in tail-bud stages while lens regeneration from the dorsal iris and from the retina occurred after removal of the developing lens (from the lens vesicle stage on). These results are open to question for the following reasons. The author admitted that some of the lenses found in the operated eyes developed from fragments of the old lens. Only 3 examples of lens regeneration from the iris were described and figured. Of the two early stages, observed only 4 days after lens removal, one was merely a thickening of the iris margin and separation of the two laminae to form a cleft, while the other was a vesicle resembling a retinal fold. The older stage, observed 12 days after lens removal, consisted of a lens vesicle with small fiber pole in contact with but not attached to the margin of the dorsal iris. A large epithelial vesicle lying in the pupil in contact with the retina was presented as an example of lens regeneration from the latter tissue. In view of the questionable nature of the cases described and figured, the other examples of lens regeneration listed in this report (18 from the iris, 7 from the retina) must also be considered doubtful.

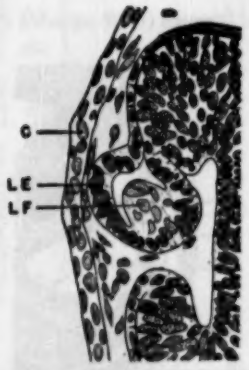

FIG. 19. LENS REGENERATION STAGE 7 IN THE EYE OF AN AMBLYSTOMA PUNCTATUM EMBRYO OF HARRISON STAGE 39

Lens induction from the prospective lens-forming ectoderm had been blocked earlier in development. Abbrev. as in Fig. 18. (Redrawn and modified from Beckwith, 1927).

Pasquini and Della Monica (1929) reported 3 cases of lens vesicles attached to the iris in larvae of the same species 8 to 10 days following lens removal at stage 46. No figures are given, however, and difficulties in their interpretation of results on anurans (to be discussed later) throw doubt on these cases. Pasquini (1927) mentioned the fact that, very rarely, a lens developed from the pupillary margin of the optic cup when the eye failed to come into contact with the overlying ectoderm after operations on the optic vesicle in *Pleurodeles waltl*. It would seem probable that many of these lenses, interpreted as resulting from Wolffian regeneration, actually formed from fragments of the lens or of ectoderm competent to form a lens, as in the experiments of Stone and Dinnean.

From this survey of the evidence so far available for the urodeles, it would appear that Wolffian lens regeneration occurs in all species of the genus *Triturus* that have been studied, in *Salamandra salamandra* and probably in *Salamandrina terdigitata*; that lens regeneration in *Hynobius unnangso* is limited to embryonic stages and is still open to some question; and that, in view of the conflicting evidence, lens regeneration in other urodeles must be considered as not yet definitely established by any of the investigations reviewed here. Of some interest is the fact that this capacity has so far been demonstrated conclusively only for species belonging to the family Salamandridae.

C. Regeneration of a lens in anurans

Numerous authors have reported lens regeneration from the iris in embryos and larvae of anurans; others have obtained negative results, frequently

TABLE 8

Lens regeneration in anurans

SPECIES	RESULT IN			AUTHOR
	Embryo	Larva	Adult	
1. *Bombina bombina*	—	n	—	Nikitenko, 1937
	—	p	n	Nikitenko, 1939b
2. *Bufo bufo* (=*vulgaris*)	p	—	—	Manuilowa, 1935b, 1936
	—	n	—	Nikitenko, 1937
	—	p	n	Nikitenko, 1939b
	—	—	n	Okada, 1939
	n	—	—	Okada, 1943a
	—	p	—	Pasquini and Della Monica, 1929, 1930
3. *Bufo viridis*	—	n	—	Manuilowa, Machabeli, and Sikharulidze, 1938
	—	p	n	Nikitenko, 1939b
4. *Discoglossus pictus*	—	p (iris grafts)	—	Monroy, 1939
	—	p	—	Pasquini and Della Monica, 1930
5. *Hyla arborea*	—	—	n	Okada, 1939
	p	—	—	Peltrera, 1939
6. *Pelobates fuscus*	—	n	—	Nikitenko, 1937
	—	p	n	Nikitenko, 1939b
	—	p?	—	Wachs, 1920a
7. *Rana arvalis*	—	p	n	Nikitenko, 1939b
8. *Rana catesbiana*	p	—	—	Pasquini, 1932
	—	p	—	Pasquini and Della Monica, 1930
9. *Rana clamitans*	p	—	—	Emerson, 1940
	—	n	—	Stone and Sapir, 1940
10. *Rana esculenta*	p	—	—	Filatow, 1925
	p	—	—	Gostejewa, 1935
	p	—	—	Jolly, 1950
	p	—	—	Manuilowa, 1935b, 1936
	p	—	—	Manuilowa and Kislow, 1934
	—	n	—	Nikitenko, 1937
	—	p	n	Nikitenko, 1939b
	—	p	—	Pasquini and Della Monica, 1929, 1930
	p	—	—	Perri, 1934, 1936
	p	—	—	Spirito, 1928
	p?	—	—	Wachs, 1920a
11. *Rana japonica*	—	—	n	Okada, 1939
12. *Rana nigromaculata*	—	—	n	Okada, 1939
	—	n (iris grafts)	—	Okada, 1943a
13. *Rana palustris*	p?	—	—	King, 1905
14. *Rana pipiens*	—	n	—	Stone and Sapir, 1940
	p	—	—	Emerson, 1940
15. *Rana ridibunda*	—	p	—	Manuilowa, Machabeli, and Sikharulidze, 1938
16. *Rana rugosa*	—	—	n	Okada, 1939
17. *Rana sylvatica*	—	p	—	Pasquini and Della Monica, 1929, 1930
	—	n	—	Stone and Sapir, 1940

TABLE 8—*Continued*

SPECIES	RESULT IN			AUTHOR
	Embryo	Larva	Adult	
18. *Rana temporaria* (=*fusca*)	—	n	—	Alberti, 1922
	p	—	—	Jolly, 1950
	—	p	—	Kochs, 1897
	p	—	—	Manuilowa, 1935b, 1936
	p	—	—	Manuilowa and Kislow, 1934
	—	n	—	Nikitenko, 1937
	—	p	n	Nikitenko, 1939b
	p	—	—	Peltrera, 1939
	—	p	—	Petersen, 1921
	—	n	—	Woerdeman, 1922

— = not studied.
n = negative, no lens regeneration.
p = positive, lens regeneration.

in the same species. Table 8 summarizes this evidence for 18 species. As in the studies on urodeles, the picture is greatly confused by the disposition of many authors to regard any epithelial vesicle or any lens tissue found subsequent to lens extirpation as having originated by regeneration from the iris. This assumption is made without regard to the danger of incomplete lens removal or to the need for obtaining examples of the critical early stages where the developing lens is still attached to its iris origin.

The cases listed under "Embryo" comprise those where lens formation was reported as occurring from the pupillary margin of the eyecup a few days following an operation intended to prevent lens induction from the ectoderm overlying the optic vesicle or after removal of a very young lens anlage. Filatow (1925) removed the prospective lens ectoderm plus the outer part of the optic vesicle in early tail-bud embryos of *Rana esculenta*, while Wachs (1920a) cut away the lens and outer part of the eyecup in older tail-bud stages. In both experiments, head ectoderm was allowed to heal over the wound. Wachs later found lenses in the operated eyes but could not ascertain their origin. Filatow figured two cases of supposed lens regeneration from the margin of the eyecup 8 days after the operation. He described the course of lens regeneration as an outgrowth of typical retinal tissue from the eyecup margin which later differentiated into a lens. He claimed that this process occurred in all of the operated embryos which were raised to 7 mm. or more in length: "Bei allen meinen Versuchen an *Rana esculenta*, wo das linsenbildende Epithel entfernt wurde, bildete das Auge seine Linse verhältnismässig spät (nämlich bei der Länge des Embryos von etwa 7 mm.) aus dem Rande des Augenbechers" (p. 56). His descriptions certainly do not resemble the course of events in embryos or larvae of *Triturus*, and they give the impression that he was observing folds of retinal tissue associated with lentoids. The origin of the latter must remain an open question. Following removal of the optic vesicle or cup together with the lens-forming ectoderm or developing lens anlage in *Rana esculenta* and *R. temporaria*, Jolly (1950) described the reconstitution of an eye from the optic stalk and the occasional development of a lens from the margin of the dorsal eyecup only four or five days after the operation. However, his drawings of three of these cases do not show sufficient detail for one to determine the nature of the structures involved or their relation to the eyecup margin.

Manuilowa and Kislow (1934) reported the appearance of 19 lenses of *Rana* tissue 3 to 12 days after grafting optic vesicles of *Rana esculenta* or *Rana temporaria* under the flank or gill ectoderm of axolotl hosts. Some of the younger lenses were said to be attached to the margin of the optic cup, but none were illustrated. In the one case figured, fixed 12 days after the operation, a big lens with large fiber pole, as well developed as the lenses in the eyes of the host embryo, filled the eyecup cavity but was not attached to any part of the eyecup. This lens would appear to be much too old to have developed by Wolffian regenera-

tion in only 12 days. Gostejewa (1935) described, in two cases, a lens vesicle lying next to the margin of the eyecup 3 days after grafting the optic vesicle, minus the lens anlage, under the flank ectoderm. Manuilowa (1935b, 1936) also reported lens development with beginning fiber formation from the eyecup margin in six cases 2 to 3 days after removing the young lens just after its separation from the overlying ectoderm in *Bufo bufo*, *Rana esculenta*, and *Rana temporaria*. Pasquini (1932) described three cases of lens vesicles associated with the eyecup margin in *Rana catesbiana* respectively 4, 6, and 13 days after operations involving removal of the lens plug, grafts of the optic vesicle to the flank, or partial removal of the optic vesicle. Unfortunately, the photographs are not clear enough to distinguish cellular detail. Perri (1936) presented no evidence to support his claim that, when two lenses developed following medio-lateral reversal of the optic vesicle together with overlying ectoderm in *Rana esculenta*, one of these must have developed from the eyecup margin, the other from the prospective lens ectoderm. In 1934, he also reported three cases of lens regeneration from the margin of the eyecup 5 to 6 days after a complex operation. This involved removal of the prospective lens ectoderm from a mid-neurula or removal of the prospective lens ectoderm plus the distal part of the optic vesicle from a head and tail-bud stage; after either operation, the surrounding head ectoderm was allowed to heal over the wound. This was followed by a brief transplantation of the optic vesicle plus the newly healed ectoderm to the flank and subsequent explantation into salt solution. In the one case figured as an example of lens regeneration from the eyecup, there was no continuity between the lens and the pupillary margin of the eyecup. Furthermore, the presence of lens fibers in all three examples indicate a quite rapid differentiation of the lens, like that characteristic of a lens from a source such as remnants of the prospective lens ectoderm or the periocular head ectoderm. Peltrera (1939) removed the prospective lens ectoderm in *Rana temporaria* and *Hyla arborea* embryos of 4 different stages (from neural folds approaching to an embryo with suckers and tail-bud), cut through the stalk of the optic vesicle, and then reimplanted the latter with the proximal and distal parts reversed so that the former lateral surface faced medially. The head ectoderm was allowed to heal over the wound and the animals were raised from 4 to 20 days. In most cases, two eyecups developed, one from the proximal optic stalk and one from the distal reversed portion. Varying degrees of fusion between these two eyecups were found, together with a tendency for the reversed eyecup to regulate by rotations of 90° to 135°. He reported 17 cases in *R. temporaria* and one case in *H. arborea* where one or more lens vesicles or lenses were associated with the reversed eyecup. Most of them lay next to the neural retina or near the eyecup margin. Peltrera believed that these bodies developed either from the margin of the eyecup or, by induction, from the overlying ectoderm. Emerson (1940) reported three cases in *Rana clamitans* or *R. pipiens* where a lens was associated with an eyecup which had developed from the presumptive forebrain of a late neurula grafted into the regenerating tail blastema of a tadpole. In the one case figured, fixed 12 days or less after the operation, a lens with irregular fibers was described as still connected to the margin of the eyecup, although this relation is not entirely clear in the photograph.

None of the authors cited above has presented conclusive evidence for lens development from the margin of the eyecup following operations on the anuran embryo. Instead, both the apparent lack of tissue continuity between lens vesicle and eyecup in those cases illustrated and the very early appearance of lens fiber formation would seem to point to the presence of ectoderm, competent for lens formation, or to fragments of the young lens anlage as the origin of these lenses. Other very doubtful cases are those of King (1905), following removal of the lens anlage in *R. palustris* with a hot needle, and those of Spirito (1928), where a vacuolated lens was attached by a peduncle to the ventral margin of an eyecup which had been reconstituted 5 days after incomplete removal of the optic vesicle in *R. esculenta*. Okada (1943a) reported the negative results obtained by Yamada, who removed the lens anlage at 4 stages from lens placode to primary fiber pole in *Bufo bufo*. Lens induction from the head ectoderm occurred in the two youngest stages, but no lens formation was observed from the eyecup itself.

The largest number of cases of Wolffian regeneration in anurans has been reported after removal of the lens in tadpole larvae. Although Nikitenko obtained ngative results in his first experiments (1937), he subsequently (1939b) reported, for all 7 species studied, lens regeneration

not only from the dorsal iris, but from any part of the iris margin. In the two cases illustrated, 5 and 6 days after the operation in *P. fuscus* and *R. esculenta*, a hollow epithelial vesicle containing undifferentiated cells and pigment was in contact with both dorsal and ventral iris in the first case, while, in the second, a large epithelial vesicle with lens fibers lay in contact with the margin of the ventral iris. In a brief report, Manuilowa, Machabeli, and Sikharulidze (1938) stated that lens regeneration from the dorsal iris occurred two to three days after lens extirpation in *Rana ridibunda* tadpoles, but failed to take place in *Bufo viridis* tadpoles. The results just described would again seem to indicate incomplete removal of the old lens rather than lens regeneration from the iris.

Pasquini and Della Monica (1929, 1930) described a considerable number of cases of supposed Wolffian lens regeneration in several different species of larval anurans (*Bufo bufo*, *Discoglossus pictus*, *Rana catesbiana*, *Rana esculenta*, *Rana sylvatica*). Following lens extirpation in *Bufo bufo* tadpoles, lenses were found in 5 out of 13 specimens after 13 or more days. However, no critical early stages were shown. In *Discoglossus pictus*, out of 33 operations, 24 cases of lens regeneration were reported, including lenses with fibers after 3 to 6 days and a normal lens after 9 to 13 days. None of the young lenses figured were attached to the iris even in the example fixed only 2 days after operation. Among the 17 positive cases occurring out of 25 lens extripations in *Rana esculenta* tadpoles, lens fibers were found after 4 to 6 days, normal-appearing lenses after 6, 17, and 18 days. The experiments on *Rana sylvatica* yielded 4 cases of supposed lens regeneration out of 21 operations after 4 to 13 days. Two epithelial vesicles, described as continuous with the tissue of the iris margin, were depicted in their drawings as only in contact with the iris. A third example illustrated appears to be a foliated, injured edge of the retina adjoining the iris. The two cases reported for *Rana catesbiana* were eyes containing one or two lenses found 3 and 4 months after lens extirpation.

In these results, the failure of the authors to figure young lens vesicles actually attached to the iris, the very early appearance of detached vesicles, lens fibers, and normal lenses, added to the considerable lack of correlation between stage of lens differentiation and time since lens extirpation, all seem to point to the same origin for these lenses, namely, reconstitution from fragments of the old lens. Furthermore, Stone and Sapir (1940) obtained entirely negative results after lens extirpation in 111 tadpoles of three anuran species (*Rana clamitans*, *Rana pipiens*, and *Rana sylvatica*) studied from 1 to 60 days following the operation. However, in 27 cases, various stages in lens reconstitution from lens fragments were observed in addition to 34 other similar cases where a fragment had been intentionally reimplanted. Many of the structures so formed resembled in considerable detail those reported as stages in lens regeneration from the iris by Pasquini and Della Monica. Alberti (1922) and Woerdeman (1922) failed to obtain any lens regeneration in 63 *R. temporaria* tadpoles up to 90 days following lens removal.

Reports by three other authors are also open to question. In *Pelobates fuscus* tadpoles, Wachs (1920a) described the reappearance of lenses following removal of the outer part of the eye including the old lens. However, these cases were killed too late to determine the source of this lens. Kochs (1897) reported, in one case, the appearance of a lens following destruction of the cornea and lens with electrocautery in *Rana temporaria*. In the same species, Petersen (1921), following implantation of connective tissue pieces, through a cut at the base of the dorsal iris, into tadpole eyes with the lens intact, reported a single case of a depigmented epithelial vesicle which was attached to the dorsal margin of the wound 14 to 15 days after the operation. Although similar to a lens vesicle, the exact nature of such a structure, found at the margin of a wound in a single isolated case, cannot be ascertained. Experiments performed on adults by Nikitenko (1939b) and Okada (1939) were entirely negative. Lenses were found in some eyes but were recognized as developing from incompletely removed lens fragments, especially lens epithelium.

Monroy (1939) reported lens regeneration from the iris of *Discoglossus pictus* larvae after a somewhat different operative technique. He implanted pieces of dorsal iris with or without the retina into the enucleated orbit (17 cases) and into the abdominal cavity (43 cases). No lenses developed in the first location, but 4 lenses and 5 lentoids were found in the latter site when the graft included both iris and retina. In both sites, extensive development of neural retina took place. Two lenses and one lentoid were figured. One of the lenses (16 days after operation) was very large but still seemed to be attached to the unpigmented lamina of the iris, whereas the small lens (time after operation not

given) was not so attached. That such a large lens regenerated from the iris in only 16 days and still remained attached to its source of origin seems rather unusual. In these young larvae (13 to 18 mm.), there would appear to be a possibility that some of the old lens was occasionally included with the graft, especially when the latter comprised both iris and a piece of retina. Some evidence for this is furnished by experiments of Okada (1943a) in which pieces of the dorsal iris from *Rana nigromaculata* tadpoles were grafted into the coelom, either with or without a piece of lens epithelium. No lenses were observed in the latter experiments, while, in the former, lenses were found frequently, in some cases actually fused to the grafted iris tissue.

It can be seen that the data for the anurans is conflicting. In view of the many negative results and the lack of conclusive evidence to support the positive claims, it would appear that lens regeneration from the iris has yet to be demonstrated in this group. However, it still cannot be assumed that Wolffian regeneration will never occur in the frogs and toads under any conditions. It may be that future research will reveal situations in which this capacity can manifest itself. Nevertheless, until critical positive evidence is produced, one may tentatively assume that lens regeneration from the iris is limited to a restricted number of species among the urodeles.

V. THE LENS-INDUCING CAPACITY OF THE LARVAL AND ADULT AMPHIBIAN EYE

Spemann (1905) first proposed that the role of the eye environment in stimulating lens regeneration is of the same nature as that of the optic vesicle in the induction of a lens in the embryo. If this is so, then the larval and aduit eyes should be capable of stimulating lens development not only from the dorsal iris, but also from competent embryonic ectoderm and from any other tissue retaining competence for lens differentiation. This hypothesis is obviously of great significance in any comparison between the physiology of the embryonic development of a lens and that of its regeneration. Several groups of investigators, particularly in Japan and Russia, have studied this question experimentally. Unfortunately, the work of the latter group is available in this country in large part only in the form of short papers with little detail and few to no illustrations. This renders a critical analysis of the results quite difficult.

The experiments of the Russian embryologists were performed almost entirely on anuran embryos, tadpoles and adults. In anurans, as discussed earlier, not only is it difficult to remove the lens and its epithelium completely, but also the lens epithelium itself is able to reconstitute lens fibers with ease. Therefore, this must always be taken into consideration as a possible source of any lens tissue appearing a few days after extirpation of the developing or mature lens.

It would seem logical to assume that the tissue most likely to respond to any inductive influence of the eye chamber would be young embryonic ectoderm competent to react to lens induction on the part of the embryonic optic vesicle. In the experiments of Popov (1938, 1939a, c), a piece of belly ectoderm from an early tail-bud embryo of an anuran (*Bufo viridis*, *Bombina bombina*, *Rana arvalis*, *Rana esculenta*), was marked with powdered carmine, either through small puncture wounds in the outer layer or by adhesion of the carmine to the inner layer, and then allowed to roll up into a closed vesicle with the carmine inside. A horseshoe-shaped incision was made through the ectoderm around the eyecup of a late tail-bud embryo of *Rana esculenta* or *Bufo viridis*, the overlying ectoderm was reflected from the eye, and the still attached or just detached lens plug was removed. The piece of donor ectoderm was implanted into the cavity of the host eyecup, and the overlying ectoderm rehealed in place. Lens development from the implant, including formation of lens fibers, was reported after one to three days in the great majority of cases and with implants from all of the species used. Carmine granules were found within the tissue and lumina of these lenses. Furthermore, when unmarked belly ectoderm from similar stages was implanted into the eye chambers of older tadpoles following removal of the host lens, the development from the implant of a lens with fibers in 2 to 6 days was reported by Nikitenko (1937) for *Rana esculenta*, *Rana temporaria*, *Bombina bombina*, *Pelobates fuscus*, and *Bufo bufo*, and by Manuilowa, Machabeli, and Sikharulidze (1938) and by Manuilowa (1938) for *Rana ridibunda* and *Bufo viridis*.

The Russian workers have also studied, in these same species, the competence for lens formation of the same ectoderm when brought into contact with the primary optic vesicle. From these experiments, Popov, Kislow, Nikitenko, and Canturisvili (1937) arranged these anuran species in the order

of decreasing capacity for lens induction from foreign ectoderm as follows: *Pelobates fuscus*, *Rana temporaria*, *Bufo bufo*, *Rana esculenta lessonae*, *Rana ridibunda*, *Bombina bombina*, *Rana arvalis*, *Bufo viridis*. However, more recent work appears to indicate a considerable competence for lens formation in the young belly ectoderm of all of these species with the exception of *Bufo viridis* (Gostejewa, 1935; Manuilowa, 1935a, b, 1936, 1939a; Sheina, 1940, 1944).

Using a different operative technique, Manuilowa (1935a, b, 1936) also studied the changes with increasing age in the lens-inducing ability of the eye. In her experiments, the developing lens was removed at several different stages. In one series, the surrounding head ectoderm was allowed to grow over the eye to close the wound; in a second series, the optic vesicle or cup was grafted under the belly ectoderm of a tail-bud host; and in the third series, the young belly ectoderm was transplanted over the optic anlage of the host in situ. When the operation was performed before the invagination of the optic cup, lens induction occurred readily, both from belly and regenerated head ectoderm. When performed at later stages, small lens vesicles and lenses with abnormal fibers were found after 2 to 4 days. These, Manuilowa believed, had been induced from the regenerated head ectoderm or transplanted belly ectoderm by these older eyecups from which a lens plug or a lens vesicle with thickened inner wall had been previously removed. Woerdeman (1938, 1939a) also reported, in preliminary abstracts, lens induction from axolotl or *Triturus taeniatus* neurula or tail-bud flank ectoderm when grafted over an older eyecup up to the lens plug stage (34 of Harrison).

If these results are valid, they would seem to show that the capacity to induce a lens from competent embryonic ectoderm is retained not only by the young eyecup, but even by the differentiated eye of the tadpole. However, even more unusual results have been reported by the Russian embryologists. In addition to embryonic ectoderm, various other older tissues have been implanted into host eyecups following lens plug removal (Popov, 1936, 1937; Popov, Evdokimova, and Krymova, 1937) or into tadpole or adult frog eyes following lens removal (Popov 1939b, 1945; Lasarev, 1945). Lens formation was reported after two to three days from head, body, and tail epidermis of tadpoles, body epidermis of salamanders, and from the following tissues of tail-bud embryos: brain, spinal cord, optic vesicle, epidermis, and somites. However, Manuilowa (1939a) obtained only a few doubtful epithelial vesicles from late tail-bud and young tadpole epidermis brought into contact with the optic vesicle of early tail-bud embryos in *Rana temporaria* and *Rana esculenta*. Popov and Manuilowa both concluded that not only does the eye in larval and adult anurans retain its capacity to induce a lens, but also that this action is stronger within the eye chamber of the older animals than that exerted by the embryonic optic vesicle. The high frequency of lens differentiation, following implantation into the eye chamber, of tissues that react to the optic vesicle with difficulty or not at all (*Bufo viridis* embryonic ectoderm, tadpole epidermis, differentiating embryonic tissues) is believed to be due to this stronger action operating over a more extended period of time plus the isolation of the implant from its normal surroundings.

In assaying the validity of these results, there are several points to be considered. First, there is the previously mentioned difficulty in the complete removal of the lens in anurans and the great capacity for fragments of lens epithelium to reconstitute lens fibers (Stone and Sapir, 1940; Okada, 1939, 1943a, b). That this might be a source of the lenses observed was considered only briefly by Popov, Evdokimova, and Krymova (1937). Second, although the carmine marking of the implant, utilized in some of the experiments to provide a basis for distinguishing host and donor tissue, does lend support to the author's conclusion that lenses developed from the implanted ectoderm, there is still a possibility that the carmine did not remain confined to the donor tissue. Close association of implant and host tissue might result in a contamination of the host tissue with carmine granules separating from the graft or released due to cell injury. This would be particularly likely if the graft itself was inserted into a sac of host lens epithelium remaining in the eye, as occurred in some of Okada's (1943b) experiments. Third, many of the structures illustrated and classified as lenses appear to be only undifferentiated epithelial bodies. In addition, the appearance of lens fibers only two or three days after the operation, the diversity of tissues supposedly forming a lens, and the appearance of lenses with anuran-sized nuclei following grafts of urodele tissue to anuran eyes (Popov, Evdokimova, and Krymova, 1937) all point to host tissue rather than to the implant as the source of

the lenses observed. Furthermore, even in the experiments of Manuilowa, there were figured no certain cases of lens development from the ectoderm overlying the optic cup when the lens anlage was removed in the lens plug stage and later. The structures shown were either small vesicles unattached to the overlying tissue or quite large lenses with abnormal lens fibers which had developed only 3 to 4 days after the operation. It can be concluded that the studies just reviewed have failed to provide sufficient evidence to prove that the capacity for induction of a lens has been retained by the larval and adult amphibian eye.

Schotté and Hummel (1939) reported somewhat similar experiments in which 2- to 8-day-old limb or tail regeneration blastemata from adult *Triturus viridescens* and larval *Amblystoma punctatum*, *Rana clamitans*, *Rana pipiens*, or *Hyla crucifer* were implanted, homo-, hetero-, and xeno-plastically, into the left eye chamber following removal of the host lens. Lens extirpation alone was performed on the right eye, which served as a control. Fixation occurred 3 to 12 days after the operation. The results can be summarized in the following table (Table 9).

The source of the lenses in the control eye was found to be incompletely removed pieces of the old host lens, as ascertained by a series of 24 additional operations involving reimplantation of pieces of the lens epithelium into the tadpole eye. Although recognizing the danger from this source, Schotté nevertheless believed that lens formation at the expense of the implanted blastema had occurred. For this conclusion, he gave the following criteria:

1. The greater frequency of lens formation in the eye with the implant than in the control eye (20.5% vs. 9%; P.E. 2.7%; Difference = 4 × P.E.)

2. Absence of a lens capsule accompanying the lens epithelium in those lenses that were believed to be derived from the graft.

3. Bridges of cells between the implant and the lens.

4. Material of apparent implant origin (blood cells, notochord) found within or closely associated with a lens.

There are several difficulties with these criteria. Some of the examples figured as cases of early lens development from the graft appear to be merely solid, rounded masses of mesenchyme with no evidence of lens fibers. Since structures of this nature were evidently classified under lenses and lentoids in the tabulation, they would naturally make this figure higher on the side with the implants than on the control side, even though there had been no lens fiber differentiation from the implanted blastemata. Furthermore, as suggested by Okada (1943b), the implantation of the blastema might tend to push partly removed fragments of the old lens epithelium back into the eye chamber where they could easily develop into a lens. Both of these

TABLE 9

Implantation of limb or tail regeneration blastemata into the eye chamber

(Data selected from Schotté and Hummel, 1939.)

LEFT EYE WITH GRAFT							RIGHT EYE CONTROL		
Donor	Host	No. operated	No. graft recovered	Lens or lentoid			No. operated	Lens or lentoid	
				No.	% of total	% of those with graft		No.	%
A1 urodele	urodele	57	—	—	—	—			
A2 anuran	anuran	4	—	—	—	—			
total for A		61	37	3	—	8			
B1 urodele	anuran	80	—	—	—	—			
B2 anuran	urodele	15	—	—	—	—			
total for B		95	63	29	—	46			
Total for both series		156	100	32	20.5	32	156	14	9

—, Data not given for these subdivisions.

factors render the statistical comparison of lens frequencies in the experimental and control eyes less significant.

According to Schotté's data (Table 9), 46 per cent of the eyes with implants also contained developing lens tissue in group B (hosts mostly anurans), whereas such lens differentiation was found in only 8 per cent of the eyes in group A (hosts mostly urodeles). Since complete extirpation of the lens is much easier in urodeles than in anurans, these figures tend further to implicate the host anuran lens as the source of the lens tissue observed later on.

The criterion of the absence of a lens capsule has been questioned by Okada (1943b), since this membrane may become separated from the lens epithelium and lenses with no capsule may then develop from the latter source. Furthermore, close secondary association of lens fragments and implanted tissues was observed by Stone and Sapir (1938) and by Okada (1943b). The latter found cases where, following removal of the lens fiber nucleus alone, implants had then been inserted into the sac of lens epithelium still remaining so that the implant developed completely surrounded by this epithelium, part of which subsequently differentiated into a mass of lens fibers. The resulting structures resembled very much Schotté's case of notochord and lens. Furthermore, Emerson (1940) failed to obtain any lens development from blastemata produced by regenerating tadpole tails either when an eye was developing within the blastema, following a graft of the presumptive forebrain of a late neurula (72 cases) or when the blastema itself was grafted over the embryonic optic vesicle (178 cases). A repetition of Schotté's experiments by Stone and Sapir (1938) also yielded entirely negative results for any lens transformation of blastema cells.

The remaining work bearing on this problem is that of Ikeda (1936b, 1938a, 1939) on the urodele *Hynobius unnangso*. In the first experiments (1936b), the lens anlage with surrounding ectoderm or the developing lens alone was removed from the eye at 8 different stages, from lens placode to well differentiated lens with completed primary fiber pole (Table 7, Nos. 5–12, p. 27). In the 6 younger stages, lens formation was observed from the head ectoderm which healed over the wound, varying in frequency from 100 per cent for stage 5, to 4 per cent for stage 10. In the two older stages (Nos. 11 and 12), lens development failed to take place from the prospective cornea left in place over the eyecup.

In further studies, the same author (Ikeda, 1939) implanted a piece of prospective or dif-

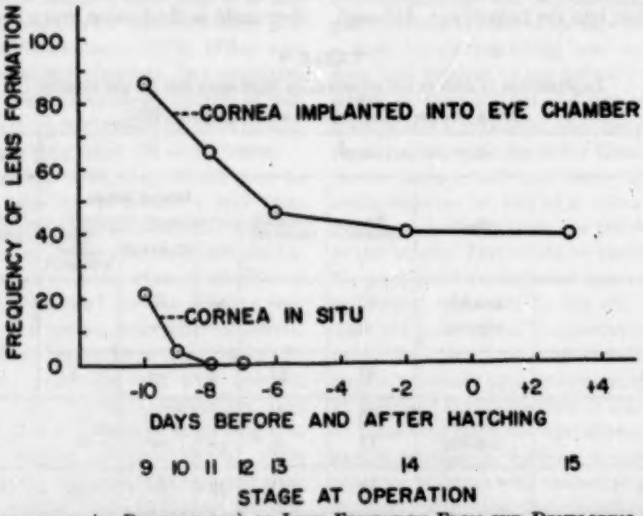

FIG. 20. FREQUENCY (IN PERCENTAGES) OF LENS FORMATION FROM THE DEVELOPING CORNEA OF HYNOBIUS UNNANGSO EMBRYOS AND LARVAE OF DIFFERENT AGES

Stages from Table 7. Data are shown both for the in situ cornea (Ikeda, 1936b) and for corneal implants into the eye chamber (Ikeda, 1939). (Modified from Ikeda, 1936b, 1939).

ferentiating cornea into the eye of a young larva with 2 to 5 gill branches (Table 7, No. 12) following lens extirpation. The grafts were taken from donors of 5 different stages (Table 7, Nos. 9, 11, 13, 14, 15; Fig. 20). The two youngest (stages 9, 11) overlapped the four oldest (stages 9–12) used in the 1936b paper, and the two oldest (stages 14, 15) were animals with forelimb-buds just before and just after hatching. Of the 818 animals, fixed 5 to 31 days after the operation, 271 had retained the implant. Of these, 189 were fixed after 10 days or later and were therefore of use in an analysis of lens formation from the graft. Ninety-five cases (50%) of these corneal implants showed stages in lens differentiation. The frequency was greatest for the series with the youngest implants and decreased in those with older implants (Fig. 20). It can also be seen from this figure that the frequency of lens development from the prospective cornea was much greater when this tissue was grafted into the eye chamber than when it lay over the eyecup, as in the 1936b experiments. Ikeda attributed this difference to the presence of an intact layer of mesenchyme under the cornea, in situ, as well as to the isolation of the implant from its normal surroundings.

The corneal grafts were observed to roll up into vesicles either with the outer epithelial layer outside and mesenchyme inside or, conversely, with the outer epithelial layer inside and mesenchyme outside. In both types of arrangement, the mesenchyme eventually separated from the epithelium, and lens formation occurred from the inner, basal epithelial layer (Fig. 21). That portion of the cornea which did not contribute to the lens usually developed into head epidermis containing Leydig's cells.

Further evidence for lens induction by the larval eyecup was given by experiments in which nasal placodes were implanted into the eye chambers of newly-hatched larvae after lens removal (Ikeda, 1938a). Thirteen cases of lens formation from the implanted placode were observed out of 179 implants remaining in the eye chamber for 10 to 13 days. The illustrations show a few lens fibers embedded in the surface of a mass of nasal tissue or larger lenses attached to that tissue. Similar lens formation from nasal placodes occurred in 10 out of 21 cases when the placode had developed close to a primary optic vesicle grafted into the head mesoderm or into the fourth ventricle of the brain. From these relative frequencies, Ikeda concluded that, while the larval eye chamber can induce a lens from reactive tissue, this action is not as strong as that of the embryonic optic vesicle.

Ikeda's evidence constitutes the best yet available in favor of the retention of a capacity for lens induction by the larval eye. The danger of contamination by incompletely removed parts of the old host lens would seem to be minimized by the large number of simple lens extirpations performed by the same investigator on these same stages of *Hynobius*; in these, no lens development occurred either from lens fragments or from the iris (Ikeda, 1934b, 1936b, 1938b, 1939). In the case of the implants of cornea, several of the cases illustrated show a lens with fibers developing from an implanted vesicle of corneal epithelium 21 or more days after the operation. The only other apparent source of contamination would be part of the donor lens epithelium grafted with the cornea. Since these structures are easily separable in all of the stages used here, except perhaps the youngest, such contamination would seem likely only in this earliest stage. It might account, however, for the presence of two large lenses illustrated, which were found in eyes of this youngest series only 10 and

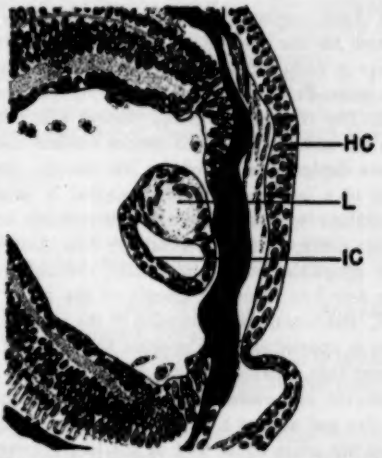

FIG. 21. LENS FORMATION FROM A PIECE OF CORNEA, 25 DAYS AFTER ITS IMPLANTATION INTO THE EYE CHAMBER OF A YOUNG LARVA OF HYNOBIUS UNNANGSO

The implanted cornea was oriented with its outer layer facing the lumen of the vesicle. Donor, stage 15 in TABLE 7. HC, host cornea; IC, implanted cornea; L, lens, developed from the implanted cornea. (Drawn and modified from photograph in Ikeda, 1939.)

14 days after operation. The smaller number of positive cases obtained with the nasal placode implants casts more doubt here. These might be due to accidental inclusion of donor prospective lens ectoderm with the grafted nasal placode. However the author failed to mention any lenses associated with 98 similar nasal placodes grafted together with an optic vesicle into the head mesoderm or fourth ventricle of the brain and which had become separated from the influence of this optic tissue.

It can be concluded that the evidence from anurans is subject to question due to the difficulty of complete lens extirpation in these forms and the lack of a critical method for distinguishing host and donor tissue. The experiments on *Hynobius* are, however, indicative of a continuing lens inductor in the larval eyecup. Further work needs to be done, particularly on urodeles, in which embryonic ectoderm, competent for lens formation, as well as developing cornea, would be implanted into host eye-cups of different ages. What is most needed for a really critical analysis is a reliable method of distinguishing the host and donor tissue at all times.

VI. SUMMARY AND CONCLUSIONS

1. Lens regeneration from the margin of the dorsal iris has been shown, by many authors, to occur in both larvae and adults of 13 species of the genus *Triturus*.

2. The changes occurring during this process are the same in all of the species studied and involve depigmentation of the iris margin, formation of a lens vesicle, differentiation of primary lens fibers from the inner wall of the vesicle, subsequent differentiation of secondary lens fibers from the equatorial zone, and finally, detachment of the new lens from the margin of the iris.

3. The rate of differentiation of the regenerating lens is approximately the same for larvae of different ages, whereas adults exhibit a slower rate. However, in the adult, the lens grows more rapidly in size and attains a larger final size, although it does not quite equal that of the lens removed.

4. Although there are some discrepancies in the evidence, the major part indicates that lens regeneration is initiated by the absence of some product of the activity of the lens rather than by the removal of mechanical factors associated with it. However, the presence of a free iris margin also appears to be necessary.

5. The ocular environment usually seems to be required for the early stages of lens regeneration from the iris. However, "self-differentiation" in a foreign site can occur after the lens vesicle stage has been attained. The essential element may be associated with the activity of the neural retina.

6. Pieces of dorsal iris lying free in the eye chamber can regenerate a lens.

7. Following lens extirpation, a single lens normally regenerates from the pupillary margin of the mid-dorsal iris. However, regeneration of one or more lenses from the nasal or temporal parts of the iris can be brought about by dividing the eye chamber into compartments with an artificial partition or by replacing the mid-dorsal iris with ventral iris.

8. By inserting a piece of cornea, celluloid, or pliofilm horizontally through the dorsal iris, regeneration of two lenses can be brought about, one developing from the pupillary iris margin and one from the free margin next to the corneal implant.

9. When the iris is divided into sectors which are then implanted singly into lensless host eyes, the capacity for lens regeneration is found to be greatest in the mid-dorsal marginal piece; it falls off, both nasally and temporally, around the border of the pupil and dorsally away from the pupillary margin. No lenses with fibers regenerated from the ventral half of the iris in these experiments. However, pieces of the pigmented layer of the dorsal retina are also capable of lens formation when similarly grafted.

10. Experiments involving rotation of the optic vesicle indicate that localization of competence for lens regeneration is fixed between stages 25 to 28 concomitantly with fixation of the mid-ventral location of the fetal (choroid) fissure.

11. When, after 180° rotation, an eye has regulated so as to develop a mid-ventral fetal fissure, there is also a regulation in the lens competence gradient in the iris, such that pieces from the new mid-dorsal, originally mid-ventral, sector now show the highest frequency of lens regeneration in iris grafts.

12. Lens regeneration from the dorsal iris will occur following removal of the embryonic lens plug or the very young lens, but not until the outer layer of the dorsal iris has become pigmented.

13. If lens formation from the prospective lens ectoderm is prevented in an embryo, then a lens will develop from the dorsal iris, but not until after

a delay of two weeks or more. At this time, the eye has differentiated sufficiently so that the outer layer of the iris is entirely pigmented.

14. When attempting to ascertain whether lens development from the iris will occur in a particular species of animal, one must always take into account the possibility of lens formation from pieces of prospective lens ectoderm or fragments of the old lens left behind after the operation. For this reason, a series of critical stages, showing the successive changes taking place in the dorsal iris, is necessary for proof of lens regeneration.

15. Lens regeneration from the iris occurs in *Salamandra salamandra* larvae, but at a slower rate than in *Triturus*. It probably also occurs in *Salamandrina ter-digitata*. It may take place occasionally in embryos of *Hynobius unnangso*, but not in larvae or adults. It would seem to be doubtful if any other species of urodele yet studied has this capacity.

16. From the evidence now available, lens regeneration from the iris in anurans would also appear to be of questionable occurrence.

17. The hypothesis that the activator involved in lens induction by the embryonic optic vesicle is also present in the eye of larval or adult amphibians has yet to receive substantial confirmation from experimental data. However, there is evidence that prospective cornea can develop into a lens when implanted into the eye of a young *Hynobius* larva.

18. It can be concluded that the pigmented epithelium of the iris of some species of salamanders possesses a unique capacity for developing into a highly specialized tissue of an entirely different structural and functional nature, namely, the crystalline lens. This occurs in response to the removal of the lens and in the environment provided by the eye chamber. The initial development of a lens from the prospective lens-forming ectoderm in the embryo has been shown to depend, in most species of amphibia, on the action of the underlying optic vesicle. These two methods of lens formation thus provide excellent material for comparing the physiological mechanisms of embryonic induction and of later regeneration in the case of an organ which is highly specialized on both a morphological and chemical level.

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NEW BIOLOGICAL BOOKS

The aim of this department is to give the reader brief indications of the character, the content, and the value of new books in the various fields of Biology. In addition there will occasionally appear one longer critical review of a book of special significance. Authors and publishers of biological books should bear in mind that THE QUARTERLY REVIEW OF BIOLOGY *can notice in this department only such books as come to the office of the editor. The absence of a book, therefore, from the following and subsequent lists only means that we have not received it. All material for notice in this department should be addressed to H. B. Glass, Associate Editor of* THE QUARTERLY REVIEW OF BIOLOGY, *Department of Biology, The Johns Hopkins University, Baltimore 18, Maryland, U. S. A.*

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GENERAL BIOLOGY: PHILOSOPHY AND EDUCATION

AN INTRODUCTION TO SCIENTIFIC RESEARCH.

By E. Bright Wilson, Jr. McGraw-Hill Book Company, New York, Toronto, and London. $6.00. xiii + 375 pp.; ill. 1952.

This book is an important and long overdue experiment in the organized presentation of principles and practices basic to the repertoire of the working scientist. No claim is made that the work supplants completely the costly and often grossly inefficient apprenticeship system that now forms the basis of much training of scientists. Rather, the book is intended as a supplement and guide to the practical experiences of actual research work for the advanced student. It should be to laboratory practice what formal courses and seminars are to extensive and selective reading. The author (a physical chemist) has managed to integrate a diversity of good research practices without excessive dependence upon any specialty for his illustrative material; examples and illustrations are drawn from medicine, physics, sociology, chemistry, engineering, and many other fields. The approach is entirely practical. A considerable variety of methods and techniques is incorporated into a relatively few generalized principles relating to the conduct of research. No more than a paragraph or two is devoted to such esoteric subjects as scientific epistemology. One consequence of this practical and highly general approach is to make the coverage of any one subject relatively brief. A broad coverage rather than a deep one is intended by the author. This by no means implies that discussions of particular topics are superficial. Ideas, methods, and techniques are presented with nearly an optimum of thoroughness and conciseness and a minimum of excursions into unnecessary details. The discussion of sequential analysis, for example, requires barely more than two pages. Although scarcely sufficient an exposition to permit extensive applied use of this difficult and complex device, by presenting its logical basis the reader is enabled to recognize situations which would make more detailed study of this tool worthwhile. Each chapter is then concluded with an excellent set of annotated references to each topic treated in the chapter.

The larger fraction of the book (6 chapters) is devoted to one aspect or another of the mathematics of research. These discussions rarely become very involved, but some mathematical sophistication on the part of the reader is assumed. A remote acquaintance with calculus will carry most readers through. An unusually good chapter on the design of apparatus is included. It was a pleasant surprise to learn that there is a remarkable number of generalized principles of design and operation of equipment applicable to nearly

all disciplines. Other highly informative chapters include discussions of the choice, execution, analysis, and reporting of experiments; search of the literature; and elementary scientific method. Particularly to be recommended is the chapter on the design of experiments.

To the accomplished scientist, some of this book, particularly the early chapters, may seem preoccupied with an elaboration of the obvious. What seems to be no more than scientific common sense to the initiate, however, is too often acquired by the capable but inexperienced student only through costly and bitter experience. In the author's own words, "... it is only the fervor of the recent convert who has learned some things the hard way."

A book meeting so clear and broad a need as this one is a rare event. It is a pleasure to recommend it to anyone interested in learning to do good research or in learning to do it better.

O. THOMAS LAW

SCIENCE AND METHOD.

By Henri Poincaré; translated by Francis Maitland; with a Preface by Bertrand Russell. Dover Publications, New York. $1.25 (paper); $2.59 (cloth). 288 pp. 1952.

This book needs no review. It is a classic which has been reprinted by Dover Publications as a service to students of science and philosophy who either could no longer obtain it, or who found previous editions too costly. It is well printed, cheap, and of convenient size. With these advantages it should be found in every scientific library no matter how small.

One cannot fail to notice that the title page announces a preface by Bertrand Russell, which is nowhere to be found in the volume.

R. G. GRENELL

THE SOVIET IMPACT ON SOCIETY. *A Recollection.*

By Dagobert Runes; with a Foreword by Harry Elmer Barnes. Philosophical Library, New York. $3.75. xiii + 202 pp. 1953.

In a note to the reader, the author states that this book was actually written 15 years ago and is printed now just as it was written originally. The delay in its publication was due to the fact that it "could find no publisher fifteen years ago because it appeared too daring in its accusations. But the truth prevailed and today these same accusations are crystal clear to every thinking and freedom-loving person." The fact that *The Soviet Impact on Society* is now in perfect fashion illustrates how far our post-war reeducation has progressed. The process of learning the facts of life on the national level is not yet completed, of course, and apparently it has been a very painful experience for many, but, thus far, it has been well worth while. The book contains nothing new, and very little that the informed will find novel. It does, however, present a very clear and consistent picture of what Communism has been ever since the Bolshevik Revolution of 1917. It records many instances of the amazing frankness with which the Communist leaders have revealed their true aims, apparently secure in their conviction that the liberal and progressive elements would either pay no attention to them or would not take their statements seriously. Their confidence was justified, for only recently has the public become aware of what Communism really stands for. The Russians actually made little effort to deceive us or our political leaders; they merely profited by our ability to deceive ourselves. Even if Runes had been able to find a publisher 15 years ago it is doubtful if his book would have had much influence.

The real value of the book lies in its collection and organization of the facts which those who recently set our intellectual fashions found it pleasanter to ignore. It should be a very useful book for any future study of mass intellectual evasions.

CONWAY ZIRKLE

ANIMAL ANALOGY IN SHAKESPEARE'S CHARACTER PORTRAYAL.

By Audrey Yoder. King's Crown Press at Columbia University, New York. $2.50 (paper). x + 150 pp. 1947.

The authoress of *Animal Analogy in Shakespeare's Character Portrayal* considers primarily two aspects of Shakespeare's abundant use of references to animals. She takes up first his adherence to the literary tradition which, exemplified by and following Aesop, attributes human qualities to animals as a way of expounding moral teachings. Secondly, she examines his use of animal physiognomy as a device by which human character is interpreted in terms of comparison with animals of similar trait.

Her findings are presented in the rather narrow perspective of a particular type of literary study, and are likely therefore to be of more interest to professional students of Shakespeare than to either the more humanistic of biologists or the enthusiasts for the "Campus Zoo" sort of literature. The contemporary biologist may be amused, however, to know that his modern methods of quantification are emulated in graphs showing the distribution of comparative animal references in Shakespeare's plays, and the distribution of animal comparisons among individual characters in the plays. It will be interesting to see how soon the principles of the new ethology become incorporated into a tradition of literary criticism which believes that by cataloguing metaphors it can illuminate the imagination of such a past master of character study as Shake-

speare. The authoress has labored as a lioness; let the reader complete the animal metaphor at his will.

JANE OPPENHEIMER

CHANGING PATTERNS OF SCHOLARSHIP AND THE FUTURE OF RESEARCH LIBRARIES. *A Symposium in Celebration of the 200th Anniversary of the Establishment of the University of Pennsylvania Library.*

University of Pennsylvania Press, Philadelphia. $2.50. x + 133 pp. 1951.

The papers presented at this Symposium were delivered by librarians and by scholars who have succeeded in brilliantly elucidating the problems of contemporary research libraries not only from the practical but also from a far more general point of view. Scholars who are accustomed to take for granted the services of their libraries will do well to hear the eloquence with which their librarians speak of their relationships to the pursuers of ideas. It is a Librarian, and not a "Professor," who has said, for instance, that "over the land there is a growing tendency for the graduate colleges to eliminate the foreign language requirements—based always on that nice old fallacy known to historians—the argument of silence—what you don't know doesn't trouble you. The kind of intellectual arrogance behind this kind of thinking is appalling to us librarians and we tend to ignore it and to continue importing those publications our faculties say do not exist or are of no importance." This book is well worth thoughtful reading not only by those on our faculties who are unappreciative of their librarians but also by all who still believe in the mid-twentieth century that books are both our memory and our imagination.

JANE OPPENHEIMER

CONTINUOUS CREATION. *A Biological Concept of the Nature of Matter.*

By Wilfred Bronfield; introduction by Frederic Wood Jones. Routledge & Kegan Paul, London. 8s. 6d. 119 pp. + 3 pl. 1950.

The thesis of the author is that life was not simply a happy accident on this earth, flourishing because circumstances favorable for it exist, but rather that the earth itself is a product of life. The earth therefore is being continually created by the life existent on it, and its destiny is not that of a wandering planet descending into cold and darkness as the sun burns itself out. Life itself is conceived of as a "real and basal form" of existence, needing a material form through which it can be expressed, but capable of leaving matter from time to time, to reappear in other form as circumstances permit. The concept is not metaphysical, as a first glance would suggest, but basically physical in that life and energy, the latter being sun-derived, are equated. Unfortunately the bases of the present arguments are incorrect, vitiating the entire thesis. Considering the great deposits of limestone and diatomaceous earth of organic origin, as well as experiments in plant growth which are erroneously interpreted, the author comes to the novel conclusion that plants are capable of transmuting elements, thus enriching the earth by "continuous creation." Clearly a basic course in nuclear physics, not to mention biology, is needed for a reorientation of the author's belief in a biological origin of the earth.

C. P. SWANSON

LUCRETIUS ON THE NATURE OF THE UNIVERSE.

Translated and with an introduction by Ronald Latham. Penguin Books, Harmondsworth, Middlesex. 65 cents (paper). 256 pp. 1951.

The one battered manuscript of Lucretius which survived the collapse of Classical civilization has here been rendered into excellent translation in fluent twentieth century prose with paper binding, well worthy of inclusion in the vacation knapsack of a modern rationalist. Latham comments that: "In the course of 2000 years of scientific and religious experience, some articles of Lucretius' creed have become incredible, some have become commonplace. But we can still feel the impulsive force of his tremendous personal conviction, even if at times our chief impulse may be to counter his arguments and urge him to think again. There is no ancient writer who speaks more directly to the modern reader. . . .The content of current scientific theories does not lessen the value of Lucretius' poem as a poet's exposition of the outlook which has inspired much of the most fruitful work in the natural sciences. Lucretius was one of the relatively small number who have accepted the evidence of the senses at its face value, have dismissed metaphysical abstractions, Divine Providence and the immortal soul as vain illusions, and at the same time have found ample grounds for wonder and joy in the perceptible universe. . . ."

The translator has been very successful in his attempt to express the poet's meaning and something of his spirit without any wide departure from normal English usage. One can delight in Lucretius' keen mind and his enthusiasms, without continually bumping one's shins against Latin idiom or references to "Phoebus' tripod and laurel." One also realizes that, although we know more about atoms than Lucretius did, we have made less advance in some other matters. "Or tell me, Memmius, when you see your legions thronging the Campus Martius in the ardor of mimic warfare. . . does that sight scare the terrors of superstition from your mind? Does the fear of death retire from your breast and leave it carefree at the moment when you sight your warships ranging far and wide?"

EVELYN HOWARD

SPINOZA DICTIONARY.

Edited by Dagobert D. Runes; with a foreword by Albert Einstein. Philosophical Library, New York. $5.00. xiv + 309 pp. 1951.

Spinoza is considered by Runes to be "our most quoted and least read philosopher." The present volume, which might have been called an anthology rather than a dictionary, consists of a collection of small excerpts from Spinoza, arranged alphabetically according to subjects. It includes passages of several pages, including such titles as: Body, Bondage, Communion with God, Democracy, Emotions, God, Happiness, Rational Life, Will, Wisdom, as well as short paragraphs, one-sentence aphorisms, and a number of cross references, such as "Statesman—*see* Evil."

Einstein feels that the Spinoza dictionary is a valuable contribution to philosophical literature, and evaluates it as follows: "Spinoza is, among the great classical thinkers, one of the least accessible because of his rigid adherence to the geometric form of argumentation.... Yet throughout Spinoza's writings one will find sharp and clear propositions which are masterpieces of concise formulation. In the book before us no one has the word but Spinoza himself.... If the reader despairs of the business of finding his way through Spinoza's works, here he will find a reliable guide. Where there is still lack of clarity this is caused only by the fact that Spinoza himself in his struggle for clarity did not reach full perfection.... The grand ideas of the *Ethics* are brought out clearly in the book, not less than the heroic illusions of this great and passionate man."

EVELYN HOWARD

BIOLOGY: HISTORY AND BIOGRAPHY

A GUIDE TO THE HISTORY OF SCIENCE. *A First Guide for the Study of the History of Science, with Introductory Essays on Science and Tradition.*

By George Sarton. Chronica Botanica, Waltham. $7.50. xviii + 316 pp.; ill. 1952.

This, as the author states, is a first guide to the study of the history of science, with introductory essays on science and tradition. No one could be better equipped than Sarton for the accomplishment of the arduous task the book represents. Even the few short essays which precede the bibliographical sections could only have been written by a great scholar and thinker who had devoted a lifetime to the study of the broad aspects of the history of science, and who understood the major importance of this work to our culture and its place in the history of civilization. This relationship is, for the most part, greatly neglected in American undergraduate studies—a neglect which is at least partly responsible for the difference in number between our many trained technicians and the few people we "educate."

The two parts of the *Guide* should interest and have great value for both scientists and scholars, as well as for historians. The first, and unfortunately all too short part, explains the purpose and meaning of the history of science; the second part, some 230 pages, is a bibliographic summary to be used as a working basis for scholarly investigation. As a vade mecum for those who appreciate the importance of such studies, it is invaluable. The book as a whole should become an integral part of the armamentarium of all students and workers in both the sciences and the humanities.

R. G. GRENELL

A TRANSLATION OF GALEN'S HYGIENE (*De Sanitate Tuenda*).

By Robert Montraville Green, with an Introduction by Henry E. Sigerist. Charles C Thomas, Springfield. $5.75. xxviii + 277 pp. 1951.

One of the most interesting aspects of Galen's writings is the facility with which he combines the dogma of his predecessors with his own precepts, many of the latter of which were derived from careful observation and sound reasoning. Thus, in his *De Sanitate Tuenda*, the major theme, that health depends on a normal mixture of the four humors (blood, phlegm, black bile, and yellow bile) with their correct attributes (warm, cold, moist, and dry), is taken from Hippocrates, and the minor variations on diet, baths, massage, and exercise, as they relate to health and disease, are derived from his own observations and experience.

Some of Galen's precepts relating to health are remarkably modern in tone. For example, he recognized that the object of hygiene is not the correction of faults or impairments, but the maintenance of normal, existing conditions. His concepts of child care, and of the importance of fresh air, pure water, and a balanced diet in health would meet the requirements of any 20th century textbook in hygiene. He was well acquainted with the tremendous variations that exist in human constitutions, and from his own observations, learned that "one man's meat may be another's poison." Galen was a strong advocate of something akin to the scientific method, and was not at all hesitant about lambasting his contemporaries (scientists, writers, and sundry) who drew general conclusions from isolated observations.

Although a large part of the present volume is devoted to reference to his earlier writings and to recommended regimens of exercise, bathing, diet, etc., it is still a fascinating treatise, well worth the time required for reading.

B. AUBREY SCHNEIDER

THE CONCEPTION OF DISEASE. *Its History, its Versions and its Nature.*

By Walter Riese. Philosophical Library, New York. $3.75. vi + 120 pp. 1953.

Disease has been defined as a state of suffering subject to change and evolution and associated with impaired function. In this sense, disease is a destructive process. But the effort of the organism to resist destruction and to repair itself, also associated with disease, is a constructive process. To this basic antithesis regarding the nature of disease may be added a long list of similar antitheses (the intrinsic and the extrinsic; hyperfunction and hypofunction; plethora and paucity; the known and the unknown; and the *apparently* knowable and the unknowable), so that it is not surprising that a wide variety of concepts regarding the nature of disease should have evolved during the course of civilized man's history.

In this extremely fascinating little volume, the author has attempted to unfold and analyze a complete picture of disease. Beginning with the Stoic and Cosmological conceptions of disease as delineated by the early Greeks, the writer presents the chronological development of various concepts, through the anthropological approach of Hippocrates and the physiological ideas of Galen, to the anatomical, etiological, sociological, nosographical, and metaphysical philosophies of more modern times. As might be expected, something of each in the succession of conceptions has very unobtrusively passed over and become a part of the next—to the extent that no small amount of each is inherent in our modern conception of disease.

The question of whether the differences between health and disease are qualitative, quantitative, or both, is considered in the last chapter entitled Epilogue: Disease and Health. From the discussion here, it is apparent that our conceptions of disease have been shaped more directly by rationalization and interpretation than by the hard facts derived from observation and experimentation.

All the footnotes are collected at the end of the text. A short index is provided.

B. AUBREY SCHNEIDER

UGO BENZI. *Medieval Philosopher and Physician, 1376–1439.*

By Dean Putnam Lockwood. University of Chicago Press, Chicago. $8.00. xvi + 441 pp. 1951.

This study of Ugo Benzi of Siena is a labor of twenty years' love, by an author who holds to the belief that "to be a historian of medicine one should first be a historian," and who is doubly qualified for his task by his knowledge of medieval Latin learning in the wide sense and by his familiarity with medieval books and manuscripts in a narrower. The author takes up in some detail the events of Ugo's life as elucidated by contemporary documents and especially by the biography by Ugo's son Socino, which was published in 1440. The latter is presented in full both in the original Latin and in English translation. The major part of the volume, which consists of just under 150 pages of text and just over 250 of appendices, is devoted, however, to a consideration of the *Consilia* in which Ugo prescribed care and treatment for specific individual patients. If the book is in one way historical rather than medical in its emphasis, it is in another bibliographical rather than strictly historical: the *Consilia* are defined and listed and described; analysis of their structure and arrangement, their chronology and authorship and publication constitutes the essential core of the volume. The author has expressed as his purpose the interpretation of "the form and function of the consilium as a key to the activities of a typical medieval physician of the highest character and attainments." His treatment of the *Consilia* sheds considerable light on medieval medical procedure, and Lockwood has produced a monograph of particular value in that it includes information about an interesting period in the history of medical thought which has hitherto received far less attention than it deserves.

JANE OPPENHEIMER

THE APOLOGIE AND TREATISE OF AMBROISE PARÉ, *Containing the Voyages made into Divers Places with Many of His Writings upon Surgery.*

Edited and with an introduction by Geoffrey Keynes. The University of Chicago Press, Chicago. $3.50. xxii + 227 pp. + 3 pl.; text ill. 1952.

This volume of Geoffrey Keynes' has made readily available in an excellent edition an English translation of Paré's *Apologie and Treatise* and of various selections from his surgical writings, including excerpts on aneurisms, on gunshot and other wounds, on hernia, fractures, dislocations, operations for stone and cataract, on such non-surgical remedies as mumia and bezoar, and also comments on some more general aspects of surgical practice.

The *Apologie and Treatise* represents an abbreviated but extraordinarily vivid autobiographical account of Paré's experiences during fifty years as a military surgeon. Its most obvious interest to the medical reader stems from the fact that it presents in Paré's own forceful terms his defense of two of the surgical practices by which he has exerted his strongest influence and for which he most deserves his fame: namely, the treatment of wounds with blander dressings than burning oil, and the use of the ligature in place of cautery during amputation. But the value of the book for both the medical and the general reader goes far beyond its justification of specific surgical procedures.

Paré proves to have been as acute and incisive a reporter of battlefield conditions as any 20th century

war correspondent, and the state of the military casualties, as he described it, was frightful almost beyond imagination. But if the experiences of war were atrocious in the 16th century, those of submitting to surgery must have been little more bearable, with or without burning oil. Paré's records of his treatment of the wounded reveal a sharp contrast between his own attitude of kindness towards his patients and that of his contemporaries during a period in which both war and surgery were cruel according to selected modern standards. But even his mercy was mixed peculiarly with what according to our standards (still selected) would represent vilest brutality, witness his recommendation to Charles IX, in order to demonstrate the lack of efficacy of bezoar as a universal antidote, the administration of poison to a cook condemned to be hanged for the theft of two silver dishes—an experiment which was carried out under especially horrible circumstances. The rise of humanism in the Renaissance was not immediately accompanied by an advancement in what we should call humanitarianism.

But if Paré's writings reveal in the author what seems to the 20th century reader an odd contrast of kindness and cruelty on the emotional side, they show no less mingling of diverse intellectual attitudes. His interpretations of trauma and disease are inevitably colored by his unquestioning adherence to the doctrines of humors and of opposites which he inherited from his predecessors. Yet the most characteristic feature of his discourses is his repeated insistence, by parable, by precept, and by example, on emancipation from dominance by authority. "Spee'h how perspicuous and elegant soever it be, cannot so vively expresse any thing, as that which is subjected to the faithfull eyes and hands.... For antiquity and custome in such things as are performed by Art, ought not to have any sway, authority or place contrary to reason, as they oft times have in civill affaires; wherefore let no man say unto us, that the Ancients have alway done thus." Paré may seem to a generation several centuries removed from the Reformation to be a man full of bizarre contrasts, but these contrasts themselves were characteristic of the minds of his period; and as unequivocal spokesman for the independence of the mind he is one of the most eloquent of the prophets of the medical reformation.

The translation presented is that of Thomas Johnson's sonorous 17th century style, and it is accompanied by a short but excellent introduction by the editor. Four interesting portraits of Paré illustrate the book, together with several woodcuts reproduced from the 1634 edition. The book is recommended not only to those concerned with the history of surgery and medicine, but also to all who are interested in the development of intellectual independence during the scientific reformation.

JANE OPPENHEIMER

WILLIAM SMELLIE. *The Master of British Midwifery. By R. W. Johnstone. E & S. Livingstone, Edinburgh and London; [The Williams & Wilkins Company, Baltimore].* $4.00. viii + 139 pp. + 23 pl. 1952.

William Smellie was an 18th century practitioner and teacher of obstetrics, distinguished for simplicity, industry, honesty, and kindness. He performed, among others, two outstanding services for his profession. He was the first (incredible though it may seem) to describe accurately the passage of the infant's head through the pelvis during normal labor; and he was one of the pioneers in the use of the forceps. His rules for their employment, to quote Johnstone, "have formed the basis, and a great part of the substance, of all subsequent codes of rules for this purpose."

This well-written biography, which contains enlightening new material, including some from Peter Camper's *Travel Journal*, not available to Smellie's previous 19th century biographer, will of course be of particular value to obstetricians. But since Smellie happened to be a particularly kind and pleasing individual, and since we all share some curiosity as to the manner of our grand entrance, it should also prove of far wider general interest. A review of one of Smellie's own books read, in his time, "There is an air of candour, humanity and moderation through the whole book, which cannot fail to engage the reader's favour and esteem." The same compliments may be turned to this biography, which is warmly recommended alike to the medical and the general reader.

JANE OPPENHEIMER

THE HISTORY OF AMERICAN ORNITHOLOGY BEFORE AUDUBON. *Trans. Amer. Phil. Soc., Vol. 41, Part 3, 1951.*

By Elsa Guerdrum Allen. The American Philosophical Society, Philadelphia. $2.00 (paper). 591 pp.; ill. 1951.

This study is a comprehensive survey of the development of American Ornithology up to the beginning of the 19th century. The author begins by sketching the growth of ornithological lore in the Old World; then discusses the simple observations of the early travelers to the New World during the 16th century, which lead to the contributions of Mark Catesby; and thereafter among others, to those of Bartram, Vieillot, and Abbot, to close with a detailed study of Alexander Wilson.

Mrs. Allen's paper is scholarly but uneven. The chapters dealing with early colonial observations and with Catesby seem to me to be the best, but others, such as the discussion of the local bird lists compiled during the 18th century, are dull and too long. It is difficult also to understand the standards of Mrs. Allen in her judgment of the importance of the various

authors. For instance, Kalm and Vieillot receive an equal amount of space, though it is generally agreed that the contributions of the former, who was a botanist, were only of slight importance, whereas those of Vieillot were very much greater. The closing chapter on Wilson is highly subjective.

The paper is well illustrated and indexed and there is an excellent bibliography of about 850 titles.

CHARLES VAURIE

A HUNDRED YEARS OF BIOLOGY.

By Ben Dawes. Gerald Duckworth & Company, London. $5.00. 429 pp.; ill. 1952.

The first 3 chapters of this book discuss the historical framework of biology and some trends in technical advances and in numerous subjects. The succeeding chapters deal with the cell, reproduction, development, growth, heredity, taxonomy, functional problems, the nervous system and behavior, evolution, marine biology, parasites and diseases, antibiotics, agricultural biology, and research institutes.

This sweep of subject matter in so few pages leads the reader to say about the whole book what the author himself said about evolution: "The futility of attempting to compress existing knowledge of evolution into one short chapter of a book will be evident." The attempt, however, to cover almost the whole of biology in a single volume should be made more often, because it exposes the need for the development of new general theories which will simplify the presentation of biological knowledge. This book may help to hasten the day when we will be able to say about biology what Pauling has said in his beginning textbook of college chemistry: "The progress made in recent decades in the development of unifying theoretical concepts has been so great that the presentation of general chemistry to the students of the present generation can be made in a more simple, straightforward, and logical way than formerly."

Some subjects of great general significance have been treated here in a very limited way, whereas other subjects of limited significance have been given more space than they deserve. For example, the concept of the biochemical unity of life and the general view of nutrition have been treated in an indirect manner whereas the nervous system and its function occupy 3 chapters. Since the author says in his Preface, "The reader will not find in my book the usual fragments of botany and zoology out of which writers often compound 'courses' of biology," he is obliged to make thorough use of all unifying concepts. In many places his book consists of the fragments he would avoid.

Certain citations in the text (pp. 27, 28, 58, 321, 343) are not given in the literature list. The literature list on the whole, however, is good, and includes many items not generally seen in textbooks.

The book can be recommended especially to those who wish to get one man's view of the whole of biology in order to assess their own position. When read in this manner, the book will serve to point out the limits we too readily set upon our everyday thoughts, which should more often be dedicated to the construction of a more unified body of knowledge.

RALPH W. LEWIS

ORIGINS OF AMERICAN SCIENTISTS. *A Study made under the Direction of a Committee of the Faculty of Wesleyan University.*

By R. H. Knapp and H. B. Goodrich. Published by The University of Chicago Press for Wesleyan University, Middletown. $7.50. xiv + 450 pp.; ill. 1952.

At a time when our very existence as a nation may depend upon the number and quality of the scientists we produce it is obviously important that we know where our scientists come from and what the background is of their production. The *Origin of American Scientists* is a very careful and detailed study of the problem, with the emphasis upon the undergraduate training and economic condition of those who become scientists. Unlike a number of previous investigations, which were limited to "starred" scientists, the work of Knapp and Goodrich deals with the whole group listed in *American Men of Science.*

Of particular interest is the variation shown in the production of scientists by the different undergraduate institutions. Certain small liberal arts colleges were well ahead of the field, little Reed College in Oregon being the Abou Ben Adhem. The larger, more famous universities were responsible for the graduate training of the scientists but, on a per capita basis, their colleges trailed the smaller institutions. The Roman Catholic colleges were well in the rear and produced only a minute percentage of the scientists. The New England and Middle Atlantic states originally produced more scientists than other sections of the nation, but they have been losing out to the Middle West and, recently, to the Far Western states. The South has produced very few scientists.

The statistical analyses are presented in detail in 56 appendices which, together, occupy 132 pages. There is no question as to the soundness of the facts collected or of their proper treatment. By any standards this is a valuable and important work. There seems to be but one serious flaw, but one which is entirely unnecessary. In Chapters 19, Speculations and Interpretations, and 20, Conclusions, the general aspects of the work are brought together and discussed. While the contribution of previous workers is not ignored completely, the authors tend to base their conclusions almost entirely on their own findings. Actually, the conclusions should be based on *all* the available data, regardless of who

collected them. And some of the ignored data would certainly have sharpened some of the conclusions drawn and have made them much more precise. The authors find the most favorable ecology for the production of scientists in the lower middle class, but their criterion for this class is purely economic. Within this class there are great occupational divergencies and intellectual variables. For example, mediocre farmers, successful clergymen, and village shopkeepers all belong to this class, but the intellectual background of their children is very different. Previous studies had also shown that the per capita production of scientists was very different from fathers in these different occupations. Ignoring such findings has made the general conclusions inadequate.

We can be grateful, however, for the factual disclosures in the *Origin of American Scientists*, and in time, of course, they will be incorporated with all the other data and be interpreted properly.

CONWAY ZIRKLE

HANS SPEMANN. *Ein Meister der Entwicklungsphysiologie: Sein Leben und sein Werk. Grosse Naturforscher, Band 11.*

By Otto Mangold. Wissenschaftliche Verlagsgesellschaft M. B. H., Stuttgart. DM.15.00. x + 254 pp.; ill. 1953.

Mangold's biography of Hans Spemann, which represents Volume 11 of the series *Grosse Naturforscher* currently appearing under the editorship of H. W. Frickhinger, consists of two quite separate portions, the first devoted to a short outline of the principal events of Spemann's life, the second to a summary and discussion of his scientific contributions.

Mangold began as a student and continues as a scientific disciple of Spemann. His forte is his power to follow the thought and method of Spemann with a meticulousness and thoroughness worthy of his master. He has the capacity, as his experimental programme and his previous reviews have demonstrated, to produce and to organize experimental data with a high degree of accuracy and clarity, and he thus in one way becomes an appropriate investigator to review the work of his preceptor. In the scientific section of the present biography, which constitutes more than two-thirds of the book, he has given a sober, clear, and successful account of Spemann's scientific development and accomplishment, and one which will not only prove instructive to the German lay public to whom it is addressed, but which will also serve, for all professional embryologists who care to use it, as a valuable supplement to Spemann's own *Experimentelle Beiträge*.

The author is perhaps less qualified by his own particular combination of talents and prejudices to deal with the intricacies of his protagonist's personality; and the biographical section of the book suffers in that it portrays a hero-worshiper's image of a figure who was something less than truly heroic in stature. For one thing, not all of Spemann's scientific disciples would so sentimentalize as does Mangold the nature of their personal relationships with the subject of the biography. For another, the characterization seems romanticized not only in the personal, but also in a nationalistic sense. It is overpatriotic, and the repeated emphasis on German Kultur rings not only outmoded but inappropriate to American ears. More important, however, Mangold is not in the most favorable vantage point, even from the loftiness of the Heiligenberg which he now inhabits, to interpret to the postwar world Spemann's position with reference to the problems of Germany.

If Spemann loved the Germany of his youth we cannot disrespect him for so doing. But if he in fact died, as Mangold felt it expedient to proclaim in the obituary published in *Roux' Archiv* in 1942, "in einer Zeit grösster geschichtlicher Entscheidungen mit dem Blick voller Hoffnung auf eine glückliche Zukunft seines Volkes"—he died in 1941, remember—we can hardly share his political sympathies nor admire his political judgment. It is unjustified to claim for him, as does Mangold in this latest biography, that through reading Theodor Mommsen in his final years at school he had "sich damit ein weitgreifendes Verständnis für politisches Geschehen erworben." The limitations to his understanding of political events and of political action were narrow to an extreme, and it was not from the ideas of Mommsen that he absorbed the obtusity to say, for instance, what he wrote of the Freiburg *Volkshochschule*:

> Es bedarf keiner besonderen Betonung, dass manches von dem, was wir mit der Volkshochschule wollten, gerade als zeitgemäss auch zeitgebunden war. Die politische Entwicklung ist darüber hinweggegangen; sie hat in vielem unsere Wünsche erfüllt und damit unser Bemühen gegenstandlos gemacht; in manchem hat sie andere Wege eingeschlagen. Trotzdem schämen wir uns unserer Arbeit auch auf diesem Gebiete nicht, denn unser Wollen war rein (*Forschung und Leben*, pp. 290–291).

He had served from 1920 until 1933 as one of the directors of the Freiburg *Volkshochschule*, which like others of its kind had been founded at the end of the First World War to provide education at a high intellectual level for whoever should desire it, no matter what his class or background; and so to deny responsibility, during the days of Hitler when the statement was written, for the failure of an experiment which under happier circumstances might well have contributed toward German's salvation, provides a most naked revelation not only of the tragedy of Hitler's Germany but also of Spemann's incapacity to recognize the realities of the situation in which he found himself.

Quite aside from the problem of the degree of Man-

gold's sincerity in his depiction of Spemann at the peak of his development, a question arises as to the author's ability to take measure of the forces which shaped Spemann's general thought. Early in the biographical portion of the book he wrote, when describing a room in Spemann's home, "Aber trotz der Grösse und der Harmonie des Raumes spürt man, dass die Bewohner aus einem grösseren Rahmen kommen: aus dem grossbürgerlichen Haus des Kunstverlegers Spemann in Stuttgart." Size can be a matter of proportion, and it is open to debate how "gross in Rahmen und Raum" were many of the houses of the German bourgeoisie during the years of Spemann's youth. As his autobiography vividly attests, it was surely from this background that Spemann inherited what was most inhibiting to the scope of his character and to his intellectual and emotional development outside of embryology, and there was nothing in his own individuality that enabled him to overleap these limiting confines except into the field of embryology.

In spite of all of Mangold's efforts, it is difficult to escape the impression that except as an embryologist Spemann lacked what in his own language would be called *Glanz*. Indeed, what seems most fascinating about him is that in spite of his lack of particular distinction in other areas he yet could become so interesting, intellectually and emotionally, in a field requiring such depth and such sensitivity and perceptivity as the new embryology he developed. This strange paradox in his personality would, however, require powers deeper and more subtle than those of Mangold's imagination to fathom; perhaps it is in essence inexplicable, in which case Mangold may well have performed his most useful service (to the world if not to himself) in presenting, in a study which reveals as much of himself as of his subject, the personal and professional characteristics of Spemann's mind as he interpreted them. Let him who may, go beyond.

JANE OPPENHEIMER

DOCTOR PYGMALION. *The Autobiography of a Plastic Surgeon.*
By Maxwell Maltz. Thomas Y. Crowell Company, New York. $3.50. vi + 261 pp. 1953.

As the autobiography of a plastic surgeon, this book has a most apt and promising title. Since the book covers nearly the entire span of modern plastic surgery, a unique opportunity for a historical treatment of this art of transformation was presented, and in view of the facility with which the author writes this could have been a most interesting account. However, aside from the early struggles of the author in becoming established in his profession, the book contains but little medical information. Rather, it recounts a series of patient-doctor relationships, deftly handled to be sure, but with a light and frothy touch. It makes for an entertaining evening of reading, but little else.

C. P. SWANSON

BETWEEN TWO WORLDS. *The Memoirs of a Physician.*
By Benjamin L. Gordon. Bookman Associates, New York. $4.00. 354 pp. 1952.

The two worlds are a small Jewish community in Lithuania in the late 1800's, and the America to which Benjamin Gordon came to get a medical education and where he was most influential in furthering the Zionist movement. Very little medical history is woven into the tale, but it is a memorable book because of the detailed accounts of Jewish struggles under the Russian Czar, the intellectual progress of an Orthodox Jew preparing for a scholarly career under the most trying conditions, the transition from tight patriarchal control to the full awareness of American democratic freedom, and a trip to Palestine in 1909 where Gordon saw the early growth of what has since become the Israeli nation. It is not a book to be hastily read in an evening; rather it is one where the movement is slow, the writing somewhat labored, and the scenes painstakingly drawn. Yet it is a proud book about a proud people, and well worth the effort.

C. P. SWANSON

VAGRANT VIKING. *My Life and Adventures.*
By Peter Freuchen. Translated from the Danish by Johan Hambro. Julian Messner, New York. $5.00. x + 422 pp. + 4 pl. 1953.

Arctic explorer, founder of Thule in Greenland, and friend and companion of Rasmusson; friend and brother to the Eskimos; world lecturer; author of many books; author of Hollywood scenarios in which he also acted; member of the Danish underground; winner of many decorations—there are few thrills or honors left to add to the list of those already experienced by this wandering Dane who just could not remain in one place for very long. He probably knows the Arctic, from Greenland to Alaska, as does no other man, and he did much to disprove Cook's claim of discovery of the North Pole. Only Africa and the Far East seem not to have been on his itinerary, although Siberia and South America were. If the account of Freuchen's life appears incredible, it is perhaps because he is somewhat incredible himself, being, in his writings, a modest, mild, and even naive man. The book makes excellent reading.

C. P. SWANSON

THE YOUNG NATURALIST

HOW ANIMALS MOVE. *The Royal Institution Christmas Lectures 1951.*

By James Gray; illustrated by Edward Bawden. Cambridge University Press, New York. $3.00. xii + 114 pp. + 20 pl.; text ill. 1953.

Six of the Royal Institution Christmas Lectures from 1951 have been reorganized into this book for young people. By simple diagram, mechanical analogy, and occasional photograph, Gray brings clear understanding to animal locomotion, whether by swimming, walking and running, jumping and creeping, or gliding and flying. Some of the explanations will require more than average comprehension from a grade-school child but all should be easy enough for a high-school student, particularly after some introduction to physical principles in a general science course.

LORUS J. & MARGERY J. MILNE

BIOLOGY AND HUMAN PROGRESS.

By Louis Eisman and Charles Tanzer; drawings by Matthew Kalmenoff. Prentice-Hall, New York. $4.20. xi + 455 pp.; ill. 1953.

An attractively illustrated high-school textbook of biology, divided for flexibility into 10 units: the field of biology; behavior of vertebrate animals, chiefly man; human physiology; nutrition; disease; reproduction; heredity; applications in animal breeding; use of natural resources—soil, forests, wildlife; and the fossil record. The material is arranged as answers to specific questions, and includes both summary problems for individual use and topics for group discussion and laboratory study.

LORUS J. & MARGERY J. MILNE

THE STORY OF MICROBES.

By Albert Schatz and Sarah R. Riedman; illustrated by Ida Scheib. Harper & Brothers, New York. $2.75. xiii + 172 pp.; ill. 1952.

A prominent bacteriologist and a physiologist with a knack for writing at a child's level have cooperated in producing this lively and factual account of organisms at the microscopic level. Applications to human activities are evident at every turn, in the production of cheese and sauerkraut, of vitamins and antibiotics. Youngsters who read *The Story of Microbes* will have a far better idea how bacteria multiply, mushrooms grow, yeasts reproduce, molds are disseminated, and the basis for sewage disposal, limestone formation, sanitation of drinking water, and preservation with salt. The great names of microbiology are introduced, and the twin pathologies—plant and animal—take their places in agriculture and medicine.

LORUS J. & MARGERY J. MILNE

ECOLOGY AND NATURAL HISTORY

NEPAL HIMALAYA.

By H. W. Tilman, with 61 photographs taken by the author. Cambridge University Press, New York. $4.75. xi + 272 pp. + 40 pl.; text ill. 1952.

The Himalayas, with their many peaks above 20,000 feet, must represent the ultimate in challenge to anyone with mountain-climbing fever. To have explored them time and again, as the author has, apparently detracts not one whit from their grandeur, immensity, and forbidding aspect. In a very readable fashion, the author describes three journeys to various parts of the Nepal Himalayas. If there are on occasion monotonous passages of description interspersed with unfamiliar names which are necessary for proper geographical orientation, one is left nonetheless with the impression that this is truly one of the world's few unexplored pieces of real estate, rich in awe-inspiring beauty and in floral species, relatively undeveloped and yet potentially of great importance, since it borders on, and acts as a barrier between, states of vastly different political creeds. One is left with no doubts that journeys of this sort are only for the hardy, but there is also no doubt that there are compensations both personal and practical.

C. P. SWANSON

FUNDAMENTALS OF LIMNOLOGY.

By Franz Ruttner; translated by D. G. Frey and F. E. J. Fry. University of Toronto Press, Toronto. $6.50. xi + 242 pp.; ill. 1953.

This is an important addition to the literature of freshwater biology. This translation makes available in English an integrated and mature treatise on limnology by one of the leading exponents of this field. Although the two translators began by independently translating the 1940 edition of Ruttner, they later combined their efforts and, through the cooperation of Ruttner himself, had access to the manuscript of the 1952 revised edition for translation before the latter was set in type.

A table of German-English limnological equivalents is inserted before the text. At least one term, "Aufwuchs," would appear to have no English equivalent. Aufwuchs "comprises all attached organisms (except the macrophytes), including such forms as sponges and Bryozoa, which are usually considered as benthos by

American students; also included are the various forms living free within the mat of sessile forms" (p. 158). The translators found the general concept of Aufwuchs so useful that it was taken over in its entirety.

The text is divided about equally into two portions: Water as an Environment; and Biotic Communities. This organization emphasises the aquatic environment. By contrast, in the 1952 edition of Welch's *Limnology* (*Q. R. B.*, 28: 170. 1953) there are about 5 chapters on the aquatic environment and some 9 chapters on biological relations. In the Preface to the 1940 edition, Ruttner selected water as an environment as the central theme. He noted that the limnological treatises of Thienemann, Brehm, Lenz, and Welch cover biotic communities in detail and consequently stressed the progress made on the physical and chemical properties of water and the dependence of the life processes on these properties. Water as an environment is subdivided into the following sections: specific gravity, viscosity, surface tension, incident solar radiation (covered in considerable detail), water movements, carbon dioxide cycle, oxygen content, iron and manganese, nitrogen and phosphorus, other mineral substances, organic matter, and the law of the minimum.

The second section, on biotic communities, includes plankton (59 pp.), origin of lakes, shore fauna, Aufwuchs (vide supra), ooze, bog communities, and running water communities. This is followed by a good glossary of technical terms, a bibliography of 9 pages, and an index.

ORLANDO PARK

RECHERCHES SUR LA FAUNE DES NIDS ET DES TERRIERS EN BASSE CÔTE D'IVORIE. *Encyclopédie Biogéographique et Écologique, VIII.*

By C. Delamare Deboutteville and R. Paulian. Paul Lechevalier, Paris. Fr. 1,350. 116 pp.; ill. 1952.

This report gives the results of investigations on the fauna in burrows and nests of Ivory Coast mammals and birds. Included are the homes of mice, rats, and squirrels which were not identified, of *Heliosciurus*, *Anomalurus*, and *Cricetomys*, among the mammals; of *Ploceus*, *Estrilda*, a sun-bird, and several unidentified nests among the birds. The inhabitants found in each are listed. The following ecological types are recognized: pholeobionts, which include those forms limited to such a microhabitat; pholeophiles, and pholeoxenes. Among the former are a few which appear to be exclusive to one host. An interesting relationship between the inhabitants of the nest of *Ploceus* and the age of the nest is revealed. The systematic portion of this report describes new genera and species of collembolans, psocids, bugs, and beetles. Some of the conclusions derived from the observations were: only certain taxonomic groups furnish the pholeobionts and pholeophiles; whether they are attracted by odor or heat, pholeobionts may exhibit a specific or a very broad choice of hosts, and this choice is independent of the physical conditions of the burrow; pholeobionts exhibit seasonal rhythms.

HENRI C. SEIBERT

THE CLEVER COYOTE. *Part I. Its History, Life Habits, Economic Status, and Control. Part II. Classification of the Races of the Coyote.*

By Stanley F. Young (Part I) and Hartley H. T. Jackson (Part II). The Stackpole Company, Harrisburg, Pennsylvania; and the Wildlife Management Institute, Washington. $6.50. xv + 411 pp. + 1 pl.; text ill. 1951.

This book is another of the series sponsored by the Wildlife Management Institute. It consists of two separate parts, the first having to do with the life history and management of the coyote, the second with the classification of the races of the coyote. Chapters in Part I cover the distribution, habits, parasites, economic status, and methods of control of the coyote. These should be of considerable value to wildlife managers, although this value would have been enhanced, I think, by the deletion of some specific material in favor of more general summaries. The concept of coyote control through the mediation of government hunters is developed well. Particularly gratifying are the conclusions that when properly managed the coyote forms an interesting and useful part of our fauna, being far from all bad, as the public is so ready to believe. Several remarkable observations are verified in this book, notable among which are those upon the friendly associations sometimes formed between badgers and coyotes and upon the cooperative techniques often used by two coyotes in hunting such animals as antelope and porcupines. Many interesting photographic illustrations occur in Part I, but have unfortunately been badly reproduced by the publishers.

Part II should have been published separately, as it is far too technical to interest readers other than professional mammalogists and yet takes up almost one-third of the book. Lacking the specialized competence necessary to comment critically on the data presented in this section of the book, one can state only that these data consist almost entirely of formal descriptions of races of coyotes, together with many photographs of representative skulls of these races. It is interesting to note that in an animal as widespread and adaptable as the coyote only one species is recognized, even though some 19 races have been described.

JOHN CUSHING

EVOLUTION

A TEXTBOOK OF EVOLUTION.

By Edward O. Dodson. W. B. Saunders Company, Philadelphia and London. $5.00. xviii + 419 pp.; ill. 1952.

The author begins with pleasant biographical sketches of Darwin and Wallace. The subject of evolution is divided into five sections: (1) evidences of evolution from biogeography, taxonomy, comparative anatomy, comparative physiology, genetics, and paleontology; (2) evolution above the specific level; (3) the origin of variation; (4) the origin of discontinuity; and (5) a summary of current ideas on the nature of the future evolution of man. Without indicating his preference, the author presents in some detail the two leading theories explaining evolution on a specific level: the neo-Darwinian theory of the accumulation of small mutants and Goldschmidt's theory of systemic mutations.

Certain sections of the text will prove to have great appeal to the student. For example, the author devotes a goodly amount of space to Oparin's theory of the origin of living matter. Other sections equally stimulating to the student include an explanation of the widely discontinuous distribution of related species, according to Simpson, and also a discussion of the archeological remains of various types of primitive man.

This text is admirably suited to a third-year college level. The book is written in a clear and interesting manner, and the illustrations are well chosen.

SARAH B. PIPKIN

DARWIN. *Competition and Cooperation.*

By Ashley Montagu. Henry Schuman, New York. $2.50. 148 pp. 1952.

In this short volume the author presents the theory of competition as Darwin saw it, not only among lower animals but in man as well. Ashley Montagu thinks that Darwin greatly overemphasized the importance of competition as a fierce struggle for existence, though he did recognize the existence of cooperation among animals, including man. The author traces the revolt against Darwinian competition among his scientific and philosophic successors. Darwin's ideas are thought to be influenced strongly by the conditions of a highly competitive industrialized England of the 19th century. The author presents a contemporary theory of natural selection in which the "tooth and claw" type of competition, although it may exist, is of relative unimportance, and altruism and cooperation are given more prominence. Quotations are given from the "struggle for existence" school of thought. The reader is stimulated by an annotated bibliography of 103 books or papers on the general subject of altruism or cooperation in evolution.

It seems that the author considers cooperation too separate and distinct a process from competition. Actually the two are often highly interrelated. For example, war between nations of men forces intensive cooperation within the warring groups. There is considerable competition among individuals within a group of herd animals. Reading Montagu's book will cause the student to seek further information on this interesting subject.

SARAH B. PIPKIN

THE ORIGIN OF LIFE AND THE EVOLUTION OF LIVING THINGS. *An Environmental Theory.*

By Olan R. Hyndman. Philosophical Library, New York. $8.75. xxi + 648 pp.; ill. 1952.

According to the author, life began as a "germ integer," or naked gene capable of catalysing its own chemical synthesis. Bacteria, viruses, and rickettsia represent the germ integer stage of development. This is a view essentially held by most biologists. A cell possessing a haploid chromosome complement, and undergoing only asexual reproduction, is considered to belong to the second order of differentiation. The third order of differentiation includes the metazoa and is characterized by a diploid chromosome complement and sexual reproduction. Man, with his advanced cortical development represents a fourth order of differentiation, according to the author.

Frankly Lamarckian, the author attributes all evolutionary change to an attempt on the part of the organism to adapt itself to its environment in order to preserve the identity of the germ integer (gene) or aggregate of germ integers (chromosomes). The reduction division in gametogenesis of a diploid organism is regarded as being caused by the retracing (biogenetic law) of the phylogenetic history of the organism as a second-stage haploid cell. The author believes that somatic cells adapt themselves in response to an environmental stimulus. If the stimulus exceeds what the author considers the "limit of plasticity" of the somatic cell to the aforesaid stimulus, then the author believes that necessary chemical reactions pass from somatic cells to the germ cells and there cause heritable genetic changes. Gene mutations met with in the laboratory are considered to be of no significance in the process of evolution.

Hyndman also thinks that an allele may cause a heritable change in a dissimilar partner gene. This is said to be owing to an influence of the internal environment. As evidence in favor of his hypothesis that altered internal environment can cause a hereditary change the author cites both the work of Michurin and Lysenko on "vegetative hybridization" and Burbank's case of "sap hybridism."

The author states that during meiosis, "adaptive forces" tend to line up the most favorable non-ho-

mologous chromosomes on the same side of the metaphase plate and to distribute them to the same second spermatocyte or second oocyte. Even the process of crossing over is supposed to be so influenced by the "adaptive forces" as to permit the most favorable crossover chromosomes to pass to the same haploid spermatid or ootid. During oogenesis, Hyndman thinks that the more unfavorable chromosome set is discarded in the first polar body. This is called "purposeful" adaptation, in contradistinction to the random assortment of non-homologous chromosomes at meiosis, which the author acknowledges may also sometimes occur, as in Mendel's experiments. It is only charitable to suppose that the author is unaware of the vast amount of experimental work which supports Mendel's second law as a general rule, and also of the absence of any experimental work supporting the author's own hypothesis.

According to Hyndman, similarities between species do not necessarily imply a common ancestor but rather similar environments. He thinks that two species that do not interbreed must not stem from a common ancestor. If chromosome numbers of two species are not the same, this is the best proof that the species did not have a common ancestor. The author makes an exception of certain species hybrids such as the mule which prove a common ancestry of the two parent species.

The author's actual knowledge of genetic principles seems meager. Even in cases where he is acquainted with genetic facts, as with Mendel's second law, the author refuses to face facts but grasps at any so-called experimental proof (cf. Michurin and Lysenko), whenever he thinks such support his theory.

The author's style is heavy, weighed down by the invention of new terms and by considerable repetition. He scorns the theory that mutations (genetic change) are fortuitous by nature, as being "irrational."

This volume is beautifully printed by the Philosophical Library, and runs to 648 pages. The reviewer recommends the book only to libraries with a policy of including all works on the subject of evolution.

SARAH B. PIPKIN

ORIGIN AND DEVELOPMENT OF THE HUMAN RACE. *By Mabel Crawley Gilbert and Ross Winthrop Gilbert. Christopher Publishing House, Boston.* $2.25. 96 pp. 1951.

The Gilberts trace a phylogenetic history of man, based solely upon stages in human embryology. Their theory of evolution is one of special creation with a new wrinkle. The Creator, called "the Central Body" is conceived of as a real "living being of chromatic constitution and structure," with a mind akin to but superior to that of man. The Central Body, lacking in love and affection, is supposed to live in the depths of the ocean and there run a sort of scientific laboratory. He experiments in his creations and makes each species independently. The Central Body selects the genetic system for each one-celled "archecyte," which then undergoes evolution with natural selection for an endless succession of generations. After letting their fantasies soar thus far, the authors end by assuming the existence of a super-deity, the Single Universal Consciousness, which lords it over the various Central Bodies which exist on planets with sufficient water to maintain them. This little book belongs to a Jules Verne-like realm of pseudo-science.

SARAH B. PIPKIN

CATALOGUE OF FOSSIL CIRRIPEDIA IN THE DEPARTMENT OF GEOLOGY. *Vol. III. Tertiary. By Thomas Henry Withers. British Museum (Natural History) London.* £4 10s. xvi + 396 pp. + 64 pl.; text ill. 1953.

The goose-neck barnacles or stalked cirripedes are of particular interest to all naturalists because Charles Darwin monographed their Tertiary representatives (1851)—his only paleontologic venture. For a quarter of a century since Darwin's work, only casual additional contributions on these fossils have appeared in press, till Italian paleontologists (Seguenza, De Alessandri), and others after them revitalized the research; and, starting in 1938, Britain's Withers gradually monographed all fossil cirripedes of the world. His latest monograph of the series is devoted to Tertiary cirripedes, thus superseding Darwin's classic on the same group. The well organized and indexed work starts with historical and morphologic accounts, where evolutionary tendencies in the group are discussed: reduction in number of valves (exoskeletal plates), change in position of umbo, and (phylogenetic) decalcification; stratigrapho-geographic distribution is next, and the systematic description follows.

A new genus is introduced, *Aporolepas*, restricted to the Middle Eocene, and based on *Scalpellum recurvata* Bertrand. This genus is represented in the Clairborn of Alabama, by a species formerly known as *Zeugmatolepas americana*. *Acroscalpellum jacksonense* from the Jackson of Mississippi, and *Lepas stenzeli* from the Weches of Texas, are 2 new American species described. In all, 30 new species and 5 new varieties are introduced, comprising more than a third of the total number of forms from Europe and other parts of the world described in the monograph.

The numerous text figures and the 44 plates of photographs are excellent. However, the curious arrangement of rectangularly cut photographs, for the mere sake of making a symmetrical pattern of pictures in each plate, results in wide separation from each other of some of the different views of the same specimen; while it is necessary to set them side-by-side in order to visualize the whole fossil in space. It is

unfortunate that many American paleontologists are practicing this same habit of making out of their plates this or that sort of fanciful symmetrical pattern, and to do so, disregard the important rule that requires a regular arrangement of the front, rear, side, top, and bottom views of an illustrated specimen in their proper relative positions (one of the rules of projective geometry).

M. K. ELIAS

GENETICS AND CYTOLOGY

BIBLIOGRAPHY ON THE GENETICS OF DROSOPHILA. *Part Two. Bibliography No. 6 of the Commonwealth Bureau of Animal Breeding and Genetics, Edinburgh.*

By Irwin H. Herskowitz. Commonwealth Agricultural Bureaux, Farnham Royal, near Slough, Bucks. 21s. (paper). xii + 212 pp. [No date].

Part 1 of this series, assembled by H. J. Muller, carried the listing of articles on Drosophila genetics, arranged alphabetically by author, through 1938. The present bibliographical listing extends from 1939 to 1950, and includes 2841 titles. A subject index includes not only the topics covered in the listed titles, but also those covered earlier in Part 1. A third index provides additional subject coverage, but according to species. The amount of labor involved in the preparation of this work must have been immense, but the author can gain some satisfaction from the fact that its usefulness will be equally great.

C. P. SWANSON

THE GENETICS OF THE DOG. *Technical Communication No. 9 of the Commonwealth Bureau of Animal Breeding and Genetics, Edinburgh.*

By Marca Burns. Commonwealth Agricultural Bureaux, Farnham Royal, near Slough, Bucks. 12s. 6d. viii + 122 pp. + 13 pl.; text ill. 1952.

On the dust jacket this book is described as being written for practical dog breeders by an author who is both a geneticist and a dog breeder. When examined, the book turns out to be a clearly and concisely written account of current evidence concerning inherited traits in the species. The amount of technical detail is considerable enough to make it an important book for biologists and geneticists, but the dog breeder who uses it will need to apply considerable intelligence as well as an understanding of genetic theory.

The dog is a veritable gold-mine of genetic traits. Burns gives a list of more than 20 anomalies, including abnormal larynx, hemophilia, tooth irregularities, retinal atrophy, and undershot jaws, which should be of great interest to medical science because of corresponding constitutional difficulties in human beings. Variation in size is probably the most extreme of any domestic species, and great differences are noted in body conformation and the shape of the head. Selection for behavioral differences has been widely practiced, and there is enormous variability in length, color, and texture of the coat. In spite of this wealth of material, and perhaps because of it, the literature is replete with genetic evidence based only on single crosses and very frequently on single litters of F_1 puppies.

The author has summarized this material with considerable critical judgment and points out that very few complete and thorough Mendelian experiments have been performed on the dog. It is regrettable that she has, because of this incomplete evidence, raised the old ghost of the inheritance of acquired characteristics. Needless to say, there is no objective evidence which can be cited in favor of it.

This is the first attempt to summarize the literature on dog genetics since Dawson's article in the 1937 *Yearbook of the U. S. Department of Agriculture*. Over 60 articles on strictly genetic work have appeared since that time, and these are included in a useful bibliography at the back of the book.

J. P. SCOTT

MITOSIS. *The Movements of Chromosomes in Cell Division. Second Edition.*

By Franz Schrader. Columbia University Press, New York. $4.00. xii + 170 pp.; ill. 1953.

Schrader has again taken stock of the hypotheses which seek to explain the movement of chromosomes in cell division, and while some of the pessimism of the first edition (*Q. R. B.*, 19: 83. 1944) has given way to an attitude more hopeful of solution, one is nevertheless left with the feeling that a complete understanding of the intricacies of mitosis lies in the distant future. Only by degrees will an answer be formulated. Fortunately, this realization has not deterred cytologists, even Schrader himself, from a continuing attack on this subject of investigation; for he, together with Ris, Östergren, Cleveland, Hughes, Swann, and others, have made definite and promising strides toward their goal. Probably the most important discovery, but one not fully exploited as yet, is that of Mazia and Dan, who have succeeded in isolating quantities of spindles for biochemical and biophysical study. This technique, supplemented possibly by the optical studies of Inoue and Swann, and related constantly to the classical morphological approaches of Schrader and Ris, offers much hope for the future. Certainly there has been no diminution in the vigor with which these researches have been pursued, and it may well be that a third edition will be necessary before long.

C. P. SWANSON

STUDIES ON CHROMOSOMES AND NUCLEAR DIVISION. *Trans. Amer. Phil. Soc., N. S., Vol. 43, Part 3, 1953.*

By L. R. Cleveland. The American Philosophical Society, Philadelphia. $1.50 (paper). 809–869; ill. 1953.

Through a long series of papers, Cleveland has amply demonstrated that, as subjects for cytological study, the hypermastigote protozoa are uniquely excellent material. This is especially true of some of the 2- and 4-chromosome species, where the small number of chromosomes, their relatively large size and constant visibility, and their readily followed coiling and divisional cycles permit detailed studies of structure in both fixed and living states. A preceding publication, issued like this one by the American Philosophical Society, dealt with coiling phenomena, and stands as a highly significant contribution in an area where subjectivity has played no inconsiderable role. One must acknowledge this despite the fact that the interpretive aspects of the study were biassed, shallow, and often acrimonious. The present contribution follows a similar pattern.

On the positive side, detailed information is given about the fusion of nucleoli and the frequency and types of spontaneous aberrations, but the real significance of the contribution stems from the considerations accorded to the phenomena of pairing, segregation, and crossing over. The lateral separation of chromatids and half-chromatids in early prophase, their later pairing and segregation in both mitosis and meiosis, and the occurrence of 2-plane crossing over between chromosomes which only pair after they are highly condensed, are events not customarily encountered in most organisms. If the beautifully executed drawings can be taken at their face value, Cleveland has provided an example of crossing over which does not take place until anaphase separation breaks through a chiasma. In this sense, and because the association of chromatids at the centromeres may be sister or non-sister, his concept of crossing over derives from both Sax and Matsuura, although the latter is at no time accorded credit. Crossing over, consequently, results from the forces of anaphase movement and the resistance of non-sister chromatid pairing. How such mechanical means can be so accurate is problematical.

A large number of phase contrast photographs accompany the text. They demonstrate beautifully the structure and behavior of the spindle, but they are of little aid in the interpretation of the chromosomal mechanisms being considered. Acceptance or rejection of the points presented rests, therefore, on the detailed drawings which serve to explain the text.

On the negative side, there is much that may be said. To begin with, the paper is abominably difficult to read and to understand because of the necessary and constant use of such terms as chromatid, sister chromatid, half sister chromatid, and sister half chromatid. These form a nebulous and almost insidious interplay on the printed page, and one wishes there were some system of terminology which would put an end to these similar sounding but different-in-meaning words. It is no wonder that most biologists throw up their hands in horror at what to them must be an unintelligible jargon. In all fairness, however, it should be stated that the fault lies with cytologists in general and not with Cleveland in particular. On the other hand, the author is guilty of a number of inexcusable lapses. There is, for example, no attempt to relate these findings to already published material, although the necessity is obvious and the opportunity is clearly presented. Thus Matsuura has not been mentioned, although the author would have found in Matsuura's writings confirmation of his own ideas as well as a sympathetic attitude. Again, the behavior and relative freedom and independence of chromatids and half-chromatids in prophase find a parallel in the coccid study done by the Schraders, but no mention is made of their work. Whether this is due to lack of information or appreciation is not known. More serious, however, is the complete lack of comprehension of earlier hypotheses dealing with the mechanism of crossing over. A quotation, not taken out of context from the section on crossing over, reveals the misunderstanding under which the author labors: "In most material where cytological observations have been made on chiasmata the chromatids cannot be seen at all until the paired chromosomes have begun to 'open up.' Indeed many workers, since chromatids cannot be seen earlier, think only of chromosomal pairing. In fact, they think chromatids are not present when chromosomes pair, but are produced, by chromosomal duplication, after pairing has been established. *Yet, they think crossing-over of chromatids occurs before the chromosomes pair, at which time, according to their own statement, no chromatids exist. How, then, can there be crossing-over in something which does not exist?*" [Italics added].

"Not all arguments for crossing-over prior to pairing are so easily refuted as this one. If we admit four chromatids are present—even though in most organisms we cannot see them—before pairing begins—and we must do so because this is a *sine qua non* of crossing-over—there is the possibility that non-sisters pair in certain regions and sisters in other regions, and thus produce chiasmata, because crossing-over occurred earlier. What is the evidence against this? One thing is the fact that the homologous chromosomes, in many forms, lie a considerable distance away from each other prior to the time of pairing. Other chromosomes often lie between the homologues. *Facts such as these offer almost insurmountable obstacles to the idea that pieces of chromatids—sometimes very short ones indeed—travel by themselves over considerable distances, through a highly granular non-chromatin nuclear environment, and yet manage to reach the proper place on the proper chromatid before homologous chromosomes come together and begin to pair.*" [Italics added].

And the pay-off. "There are other arguments against cross-over occurring prior to pairing, but I shall not discuss them because, in my opinion, less arguments and more facts are needed if we are ever to understand the mechanism of crossing-over." The reviewer has no desire to ridicule, yet misinterpretation and contempt of previous ideas only serves to cast serious doubt on the validity of the interpretations presented, and to bring discredit to what may otherwise be an extremely important contribution. One has the feeling that this is a piece of work done painstakingly, to be sure, but in total isolation, and without the benefit of discussion with interested and competent colleagues. The same may be said about the recent *Journal of Heredity* article by Cleveland and Winchester, wherein the conclusions drawn from the protozoa studies have been erroneously applied to meiotic behavior in other organisms, e.g., the grasshopper. A fresh wind blowing over the stagnant areas of any science is invariably welcomed, and it would appear that the protozoan material, unique as it is, would introduce a new vitality into the study of cytological mechanisms. The interpretive misconceptions involved here, however, cast suspicion even on the observational aspects of the study. Furthermore, Cleveland's desire to fit, Procrustean-wise, all cytological systems into the protozoan mold indicates an acceptance of evolutionary flexibility of meiotic phenomena in his own materials but a rejection of them in other organisms.

The editor of these *Transactions* would do well to make use of a competent reviewing board which in all likelihood could have forestalled and possibly eliminated the errors of omission and commission which mar this publication.

C. P. SWANSON

INTERNATIONAL REVIEW OF CYTOLOGY. *Vol. I. Prepared Under the Auspices of The International Society for Cell Biology.*

Edited by G. H. Bourne and J. F. Danielli. Academic Press, New York. $7.80. x + 368 pp.; ill. 1952.

INTERNATIONAL REVIEW OF CYTOLOGY. *Vol. II. Prepared Under the Auspices of the International Society for Cell Biology.*

Edited by G. H. Bourne and J. F. Danielli. Academic Press, New York. $11.00. xii + 545 pp.; ill. 1953.

Through the years cytology has not remained an isolated biological discipline. Its basic nature has been such as to align it most closely with whatever associated science was in its expanding experimental phase. Prior to the turn of the century, cytology, as exemplified in the studies of Boveri, was brought to bear on the problems of embryology; with the rediscovery of Mendel's Laws and the development of the chromosome theory of inheritance, the union of cytology with genetics became a natural and an enduring one. Cytogenetics, however, is essentially a science of correlative morphological behaviors with quantitative overtones, one at the cellular and the other at the organismal level, and it was inevitable that progress in understanding the relationship of cellular morphology and behavior to morphogenesis required the interest and endeavors of the biochemist and the biophysicist. Genetics, as a consequence, turned biochemical, in part at least, while cytology joined with cell physiology, without the two, however, losing their close ties to each other. That the trend has been profitable is undeniable. The increasingly large number of papers appearing speaks for the tremendous interest in this field. The pace has been rapid, and many of the ideas conflicting, with the result that a person not working in this immediate area of research has found it difficult to appraise and digest the mountain of available data. Furthermore, the biochemists and physiologists have introduced into cytology—or, more properly, as Bourne and Danielli point out, into cell biology—a sense of competition and a tempo that is both foreign and bewildering. The need for critical evaluation and scholarly synthesis is obvious. At the pace now being maintained, this needs to be done often.

It is not possible to consider the entire field of cell biology—only an E. B. Wilson could do this with any hope of success. The next best approach, and the only one which the editors of this new series could adopt, is that of dealing with unrelated topics in the hope that all aspects of cell biology will eventually be touched upon. The proposal, in keeping with the aims of its sponsor, The International Society of Cell Biology, is to maintain the scope of these annual reviews as wide as possible. This has been done in the first two volumes, and the combined 33 papers cover cytochemistry, enzymology, structural cytology, nucleo-cytoplasmic studies, microscopy, staining and histochemical results and theory, bacteriophage reproduction, membrane permeability, and protein behavior, among others. It is not possible here to consider individual papers, but the quality in general is high, and of the usefulness of this collection there is no doubt.

C. P. SWANSON

CYTOCHEMISTRY. *A Critical Approach.*

By J. F. Danielli. John Wiley & Sons, New York; Chapman & Hall, London. $4.00. vi + 139 pp. + 19 pl.; text ill. 1953.

This book is one in a series of monographs devoted to the presentation of research in which the author has personally taken part. The work is not intended therefore to be either a text or a general review.

Initially, Danielli discusses a number of procedures which have found wide application but which are shown to be equivocal in their interpretation. The remaining

chapters deal with fixation procedures, alkaline phosphatase, aldehydes, proteins and nucleic acids, quantitative methods, and the future outlook. In dealing with each of the procedures selected for examination, Danielli has attempted to set up those requirements which must be met before definitive results can be expected. These are often, of necessity, statements of the obvious, with the result that parts of the book have a rather didactic style. The requirements for the so-called "maceration" technique and the method of centrifugal stratification, as presented by the author, are almost beyond the realm of present possibility and would appear to preclude their use.

It is difficult to avoid the conclusion that at times the author is somewhat more lenient with the alkaline phosphatase technique than with procedures with which he is less familiar. The interpretations of the findings respecting the occurrence of this enzyme in the nucleus is a case in point. Two modifications of the method give somewhat different results. The author however, without experimentally proven reasons, stresses one set of observations and discounts the other. Thus, as is often true, heroic attempts may be made to devise rigorous methods, but the interpretation of the results cannot be freed from subjectivity.

As is well known, the concepts and points of view which the author has stressed have had and continue to have a profound, directing effect on the stream of histochemical thought and research. This book is therefore recommended as essential reading to all concerned with the distribution of substances in cells. Of interest to the more general reader are a number of brilliant ideas and keen insights, often stated briefly and in passing, which are scattered throughout the volume.

NORMAN G. ANDERSON

GENERAL AND SYSTEMATIC BOTANY

POLLEN MORPHOLOGY AND PLANT TAXONOMY. *Angiosperms (An Introduction to Palynology, I).* *By G. Erdtman; Foreword by H. Humbert; with 261 illustrations (or groups of illustrations) based on the author's originals by Anna-Lisa Nilsson. Almqvist and Wiksell, Stockholm; The Chronica Botanica Company, Waltham.* $14.00. xii + 539 pp.; text ill. 1952.

The rich potential of palynology (pollen and spore science) has been available since the days of early microscopists such as Grew and Malpighi. Much of this potential remains to be exploited despite the fact that critical researches on pollen and spores have important applications to many fields of scientific endeavor. Therefore, to the present day student of palynology, it is encouraging to witness evidence of increasing activity particularly in the appearance of larger works, in addition to shorter technical papers, on pollen and spores.

The possible value of detailed, palynological studies in taxonomy has been variously, but definitively, cited by Robert Brown, Fischer, Fritzsche, Lindau, Mohl, Wodehouse, Selling, and others. In view of the vastness of any project which would be devoted to a "complete" systematic analysis of pollen and spores, it is obviously to be regretted that relatively few contemporary laboratories have supported such research. One of the best known laboratories engaged in palynological investigations has been that of G. Erdtman, at Bromma, Sweden. The present volume summarizes part of Erdtman's detailed studies of pollen carried on during the past two decades.

As stated in the Preface, the book is "an attempt to illustrate the main tenor of Angiosperm pollen morphology." From what has been already stated, it will doubtless follow that this is indeed a formidable assignment. As Humbert points out in the Foreword, this sizable volume (representing Part I of the studies) describes the pollen of representatives of some 327 families of angiosperms. The arrangement of subject matter is as follows. A concise introductory statement summarizing the various applications of palynology to related fields is followed by a brief description of preparational methods for study of pollen, both fresh and dried, methods which Erdtman has used in his laboratory. The next section is a provocative, if not partially controversial, exposition of pollen and spore morphology. For the uninitiated, it will undoubtedly prove to be in part difficult, specialized reading. This accounts briefly for the first 28 pages of the book. The bulk of the volume, through page 458, is devoted to descriptions of the pollen of angiospermous families, arranged alphabetically beginning with *Abolbodaceae* (*Xyridaceae*) and ending with *Zygophyllaceae*. An acutely necessary section, the Glossary, occupies the next 14 pages. The volume closes with a Bibliography extending through 41 pages and an Index to Families and Genera. An approach to a subject matter index is to be found in the Table of Contents (p. 1).

In the above material, there are a number of characteristics which merit special comment. The inclusion of "Taxonomy" in the formal title of this work will undoubtedly prove disappointing to some readers, in view of the alphabetical arrangement of families. This will favor, not infrequently, the use of the work as a *source* book for projected rather than demonstrated systematic work. However, such use appears to be quite in harmony with the author's stated intentions. The chapter on pollen and spore morphology serves as the basis for the technical, and often highly specialized, nomenclature utilized in the detailed descriptions occupying most of the book. For the person new to the field this terminology will be, inevitably, unfamiliar. For the specialist, this section will include items of controversy. Continuing contributions to observations

on the detailed structure of pollen grains and spores, particularly with reference to the wall (sporoderm), make it evident that there is definite need for terms which can be applied generally, and with profit, by various workers in this field. It is unfortunate that thus far we do not appear to have a large core of widely accepted technical terms.

Since other workers have contributed systems of pollen terminology, it would have been most helpful if more attention could have been given in the present volume to a summary cross-referencing specialized nomenclature with similar material already in print and in use. One feels that Erdtman has created not a few problems for the etymologist, and perhaps others, in proposing such terms as *sexine* (in which the *s* is derived from L. *sculptura* and the balance from extine or exine); *nexine* (in which the *n* is derived from L. *nonsculptura* and the balance as in the preceding); variations such as *ectosexine* which are based upon these; and LO (from L. *lux* and *obscuritas*). In the glossary most of the items are indicated by stars as being "less common." The great majority of these have been proposed by Erdtman, a fact which documents his keen interest in recording in detail, by use of specific terms, all diagnostic features of pollen grains and spores. It is to be hoped that eventually a more stabilized, and perhaps less bewildering, array of terms will emerge from various cooperative ventures in the future. The recently organized "Commission International de Palynologie" would appear to be a step in the right direction.

In a work of such monumental dimensions, it is to be expected that the individual treatments of families would vary in extent. These summaries range from the essentially discrete research monograph of some 30 pages on the Proteaceae (by Isabel Cookson and Erdtman) to few-lined entries such as that devoted to the Zosteraceae. Some discussions of families include citation to the number of species and genera investigated, whereas others do not. Reference is not always included to all of the genera that have been analyzed. Frequently the descriptions of families include strictly objective comparisons with other groups. A highly desirable feature is to be found in the many citations to the herbarium specimens from which the pollen was obtained.

All of the numerous illustrations are original. Many of the 261 figures include several components, all of which are not always clearly identified for the inexperienced reader. For example, the generally helpful plate, Fig. 3, would be improved by the addition of some simple explanation of the many small diagrams surrounding the larger, somewhat stylized drawings (palynograms) of pollen grains. Figs. 4 and 5 will suggest the high degree of microscopical skill, not to say patience, which must be acquired in order to interpret correctly the intricate structure of the pollen grain wall. These two figures are worthy of assimilation in the company of a pollen slide and a microscope of suitable specifications.

The author modestly makes no claim for the exhaustiveness of the bibliography. However, indirectly it does approach exhaustiveness by reference to Erdtman's valuable previously published lists of palynological literature. One notes several oddities in this volume's bibliography, notably the inclusion of some papers of little apparent application to the basic subject matter of the work. Such references would have been rendered more available for use if they had received citation in the appropriate section of the text (commonly, with reference to the citations to systematic analyses of families).

This comprehensive, well-printed book will undoubtedly prove to be an indispensable source book for any serious student of pollen morphology.

A. Orville Dahl

New Zealand Pollen Studies: The Monocotyledons. *A Comparative Account. Bull. Auckland Inst. & Mus., No. 3.*

By Lucy M. Cranwell. Harvard University Press. Cambridge. $3.50 (paper); $5.00 (cloth). 91 pp. + 8 pl.; text ill. 1953.

Lucy M. Cranwell Smith has contributed a valuable monograph on the types of pollen characteristic of the flora of New Zealand. This recent publication is issued jointly by the Auckland Institute and Museum and the Harvard University Press. Much of the work has been devised with an alert consciousness of the broad fundamentals underlying critical analyses of pollen and spores. In consequence, this monograph will deserve a much wider audience than its title might suggest.

The volume opens with an interesting, although somewhat diffuse, section entitled, On the Nature and Uses of Monocotyledonous Pollen. Here is diverse information on the early ceremonial uses of pollen, the taxonomic and ecological implications of pollen and pollination studies, the basic morphology of monocotyledonous pollen grains, and more. Mrs. Smith's comments on Nomenclature could well stimulate systematists to view systems such as the one proposed by Hutchinson with increased reference to pollen morphology. A helpful glossary of pollen terms prefaces two keys, first, a master key to the main pollen classes in the flora, followed by the key to pollen grains of monocotyledons. The next 51 pages are devoted to a detailed, systematic treatment of the monocotyledonous taxa found in New Zealand. The sequence of families largely follows that proposed by Skottsberg. The summaries of families and genera are such as to widen the appeal of the book. A map of New Zealand is included as an aid to the statements on range given for each species. The monograph closes with a tabulation of the

chief pollen characters of the monocotyledons of New Zealand, a fairly extensive list of references, and an index. The work is illustrated with drawings (66 figures) and 8 collotype plates made up largely of photomicrographs. The author is to be congratulated in providing the all too rarely used collotype reproduction. The presentation of fine details of wall structure, where adequate magnification has been used, is much favored with this medium. Some of the photomicrographs would have been more revealing if the original magnification had been greater.

Mrs. Smith has managed, in somewhat succinct style, to include some of her enthusiasm for research on pollen in its relations to ecology and taxonomy. Her keen interest in referring to a number of fundamental implications in juxtaposition with facts that apply specifically to New Zealand, has occasionally obscured the treatment. For example, in connection with the inclusion of the master key to the main pollen classes various materials on dicotyledons, conifers, etc., are provided. It seems a bit unfortunate that Dicotyledones and Coniferales are grouped under Lower Taxa in Table I, which is organized to refer to Monocotyledons. However, it is likely that the most important reaction to this feature will be one of regret that the author did not find it possible to include, at this time, her studies of other groups.

In the case of pollen preparations based upon herbarium material, it is not always clear that the citation is sufficiently complete to enable ready reference to be made to the individual specimen. Since many of Mrs. Smith's descriptions are new, this is an important potential problem for the future.

The author states that "pollen references tend to crop up belatedly in all directions, like stones in a New England field." However, an examination of the listed references will show that an expert selection of pertinent publications has been included. Helpful references to research on *Zostera* and to the early studies by Edgeworth will illustrate the care exercised by the author in her consideration of the literature. It follows from the above remarks that this work will prove to be of great worth to persons engaged in many aspects of pollen and spore research.

A. Orville Dahl

400 Plants of South Florida. *A Florida Nature Series Publication.*

By Julia F. Morton and R. Bruce Ledin, with 28 full-page drawings by Frank D. Venning. Text House (Florida), Coral Gables. $3.50. 134 pp.; ill. 1952.

This book, attractively printed on tinted paper, presents in nontechnical language highly condensed "word pictures" of the most conspicuous native and introduced plants of subtropical and tropical Florida. Many of the species are cultivated in gardens and along roadsides; others are characteristic wild plants of the beaches and keys.

For each species, the correct scientific and common names, family, native home, diagnostic characters, and uses are given. The species are arranged alphabetically according to their scientific names, but an extensive index of 1310 common names and synonyms makes it possible to locate easily any particular plant. The book is illustrated by 27 full-page pen and ink drawings by Frank D. Venning. A bibliography listing other publications on Florida plants is appended.

Although written primarily for the layman, this work should be valuable for botanists, horticulturists, or anyone interested in tropical plants, since it affords for quick reference accurate and concise information that hitherto has been available only from several different sources.

Albert F. Hill

Wild Flowers of Western Pennsylvania and the Upper Ohio Basin. *Vols. One and Two.*

Text by O. E. Jennings; watercolors by Andrey Avinoff. University of Pittsburgh Press, Pittsburgh. $60.00 a set (2 vols.). (1) lxxvi + 574 pp.; ill.; (2) xvi + 200 pl. 1953.

It is rarely that one is called upon to describe a work which is so superior to others similar to it in aim that only superlative terms seem at all fitting. We are, of course, accustomed and, through long exposure, inured to the extravagant claims commonly used by publishing houses to foster the sales of each and every book which rolls from their presses. It is therefore a unique pleasure to meet with a published piece which would tax the inventiveness of any advertizer to do it justice. Presented in two volumes, this work is one of the finest pieces of botanical literature, past or present.

Volume I is essentially a descriptive manual of the native and naturalized flora of an area that includes western Pennsylvania, northeastern Ohio, and adjacent portions of New York, Maryland, and West Virginia. Some 2800 species are included, the descriptions are full and accurate, and analytical keys and numerous maps are provided. In addition, a botanical history of the region has been included, together with illuminating discussions of the geology, soils, topography, climate, and plant geography of the region. Since this is an area of considerable ecological diversity, with parts of it relatively undisturbed by man, the reader is provided with a very detailed, and uniformly excellent, treatment of a single region in its many botanical aspects. As the author points out, his fifty years of extensive field work have become a book.

Volume II consists of 200 watercolors, each accompanied by a facing descriptive sheet. These paintings have every right to a place alongside the great

watercolors of Audubon's birds. Faithfulness of reproduction, subtlety of shading, fine sense of line and of spacing, and freshness of color have been uniquely combined to produce a group of botanical portraits of rare beauty, grace, and spontaneity. It is to be regretted that Avinoff did not live to see his work of ten years in bound form.

The large size of the volumes, approximately 10 x 14 inches, the high cost, and the limited edition, together with the excellence of format, mark them immediately as collectors' items. These facts alone will take many of the copies out of general circulation, but the botanical usefulness of Volume I is sufficient to make one hope that a smaller, cheaper edition can be prepared, perhaps as a field guide.

C. P. SWANSON

FLORA OF TEXAS. *Vol. 3, Part V: Umbelliferae. Campanulaceae.*

By Cyrus Longworth Lundell and Collaborators. University Press, Southern Methodist University, Dallas. $3.00 (paper). Pp. 261–366 + 20 pl. 1951.

The fifth part of this monographic state flora embraces the two families Umbelliferae and Campanulaceae, the account of the former contributed by Mildred E. Mathias and Lincoln Constance, that of the latter by Rogers McVaugh. This work, earlier announced "to be a 10-volume publication," is issued as the various accounts are completed without regard to the affinities of the groups. Family treatments are uniform as to organization—descriptions, bibliography, synonomy, citation of collections, and the like—but vary as to accompanying illustrations, the extent of life history notes, and technical commentary. McVaugh, addicted to the historical cloisters of the Texas flora, introduces biographical tidbits that cannot but help the future student of the Campanulaceae. Between the two contributions of Part Five there is a wide difference in the length of descriptions, both of genera and species. Mathias and Constance follow Bentham in writing concise descriptions which emphasize *diagnostica* and omit minor morphological details that concern McVaugh in his study of the Campanulaceae. Even where McVaugh provides full keys to the species, he describes each in comparable setigerous detail. The 7 species of *Triodanis* (Campanulaceae) are "close" and require sharp definition but, too, the 9 species of *Eryngium* (Umbelliferae) present some problems in recognition, so it would represent a different phytographic approach on the part of the authors and, as such, will contribute to the inevitable unevenness of the treatments in the *Flora*.

There is a well known corollary between "natural" plant families, like the Umbelliferae, and the prevalence of closely related taxa within the group that may be difficult to distinguish. Accordingly, synonomy arising from varying viewpoints will abound, and the Parsley Family has its share. It seems of dubious value, however, to list in a Flora of Texas Urban's many segregate subspecific taxa in *Hydrocotyle ranunculoides*, or, indeed, to include many another name duly disposed of in the published account by the same authors in *North American Flora*. When space is such a limiting factor in the publication plan of a state flora, would it not be preferable to elect life history data or local Texan characteristics of cosmopolitan species—their ecologic niche, peculiarities of dispersal, soil tendencies, and wild life relationships—rather than to elaborate on technical matters of concern to a very few botanists? In short, though we need not exactly write a *Flora* in Texas for Texans, does not a book such as Kearney and Peebles' *Arizona Flora* fill a more urgent need? It has been the plan to take the several contributors to the *Flora of Texas* into the field and demonstrate the species in nature. From these field investigations there *should* come abundant, if provisional, suggestions on the life histories of its species.

While employed by Jepson in the preparation of the *Flora of California*, I brought up the desirability of recording the sources of the illustrations by a simple device such as that which was used so effectively by A. S. Hitchcock in his *Manual of Grasses*. Jepson heartily agreed in principle, but declined the device on the premise it had not been introduced in the earlier published parts of the *Flora* and that it was ill-advised to alter the plan. I remained unconvinced, for other desirable innovations had been currently adopted. To fix the source of drawings is tantamount to such other familiar taxonomic procedures as designating type collections and their places of deposit, especially in a flora where the taxa may be very incompletely known. Whence, for example, out of a range that extends from Colorado to Mexico, came the *Aletes acaulis* plant drawn as Plate 36? Four binomials, based on different types, are concerned in this species, and there always remains a new viewpoint based on new evidence.

The drawings, chiefly of the endemic species and heretofore not illustrated in most instances, are crisp and accurate. The enlarged carpel details could be often rearranged to give pleasing balance to the plate (cf. Mathias and Constance account in Abrams' *Flora*). In presswork, this part, like its predecessors, is impeccable.

JOSEPH EWAN

CYCLAMEN PERSICUM. *Its Natural and Cultivated Forms.*

By Walter Blasdale. Stanford University Press, Stanford; Geoffrey Cumberlege, Oxford University Press, London. $1.50. 49 pp. + 5 pl.; ill. 1952.

This small, but excellent, monograph deals with *Cycla-*

men persicum, the only one of the 17 species of the genus known to the general public, and the only one which has readily responded to cultivation. It is the outcome of the author's 20-year interest in the plant.

The first chapter deals with the botanical relationships, early history, and geographical distribution of the species. The second chapter presents the distinctive morphological characters of roots, leaves, flowers, fruits, and seeds. In the third chapter the most important features of the life history are discussed: the development of seedlings, the summer period of dormancy, seed production and dissemination, hybridization, and origin. The final chapter, of special interest to horticulturists, treats of the following topics: Cultivation of the Natural Species, Horticultural Development of the Persian Cyclamen, The Persian Cyclamen and Genetics, Strains with Flat-faced Flowers, Double-flowered Strains, Strains with Fringed and Fluted Flowers, Strains with Crested Flowers, the Papilio and Rococo Strains, Cultivation as a Greenhouse Plant, and Cultivation as a Bedding Plant. The book is illustrated with 16 photographs and 7 text figures. A bibliography is appended.

ALBERT F. HILL

A GUIDE TO THE SPRING FLOWERS OF MINNESOTA. *Eighth Revised Edition.*

By Carl Otto Rosendahl and Frederic C. Butters. Burgess Publishing Company, Minneapolis. $2.25 (paper). x × 108 pp.; ill. 1951.

GUIDE TO OHIO PLANTS. *A Teaching Manual of Vascular Plants for Use in Field and Laboratory.*

By John N. Wolfe, Adolph Waller, S. S. Humphrey, and Clara Weishaupt. Long's College Book Company, Columbus. $2.75. 266 pp. 1952.

Both of these guides are for the beginning botanist, and each deals with the flora of a given area. The Minnesota guide is more narrowly restricted in its scope, but each contains a glossary, line drawings of plant parts used in identification, and keys which have proven workable in the hands of unprofessional students. Either should prove useful to one who seeks an acquaintance with midwestern and north central midwestern flora.

C. P. SWANSON

WEED SEEDLINGS.

By Anna P. Kummer; drawings by the author. University of Chicago Press, Chicago. $5.00 (paper). xxxiv + 435 pp.; ill. 1951.

A weed has often been defined as any plant that grows where it is not wanted. With this broad viewpoint in mind, it is safe to assume that few gardeners, farmers, ranchers, home-owners, or even professional botanists, have failed to wonder at some time or other whether a tiny seedling was that of a weed or of a desirable species.

This unique book should be of great assistance in answering the question, and in determining the identity of weed seedlings. Some 300 broadleaved species of the United States and Canada are adequately illustrated and described. Harmful and dangerous species are included, as well as the common weeds. Life-size drawings show the general habit and aspect of each plant, including the roots. In addition, a detached seed leaf, and the first, third, and fifth leaves are depicted, twice natural size, in order to bring out the venation, hairiness, and similar characteristics to better advantage. The descriptions, in non-technical language, emphasize those characters that are not readily obvious from the drawings. The arrangement of the species follows the Engler and Prantl system, and the nomenclature is in accord with the 8th edition of *Gray's Manual of Botany*.

An artificial key to all the species is supplied. Any special terms that may be used are defined when they first appear in the key. The book is fully indexed both as to common and scientific names.

ALBERT F. HILL

SUCCULENT PLANTS *Other than Cacti.*

By A. Bertrand; photographs in colour and monochrome by A. Bertrand and G. Richard; English text edited by Vera Higgins. Philosophical Library, New York. $4.75. 112 pp. + 30 pl.; text ill. 1953.

A companion volume to the author's *Cacti*, this book presents sound and dependable information in regard to a considerable number of succulents belonging to other families, particularly the Agavaceae, Liliaceae, Asclepiadaceae, Crassulaceae, Euphorbiaceae, and Aizoaceae. Only those species of real beauty or extraordinary appearance, and consequently those commonly cultivated or worthy to be so, are included. In order to give the reader the necessary background, the author discusses succulent plants in their native environment; their cultivation, emphasizing the fact that, although "desert plants," they nevertheless require plenty of water and need a great deal of light; their propagation; and their enemies. In the treatment of the individual families, genera, and species the essential and most easily observed of the distinguishing characteristics are presented, rather than a detailed technical account. The book is beautifully illustrated with 39 photographs and 23 colored pictures. A glossary and index are supplied.

ALBERT F. HILL

TREES. *A Guide to Familiar American Trees. A Golden Nature Guide. Sponsored by The Wildlife Management Institute.*

By Herbert S. Zim and Alexander C. Martin; illustrated by Dorothea and Sy Barlowe. Simon & Schuster, New York. $1.50. 157 pp.; ill. 1952.

The Golden Nature Guides constitute a series of popular books written by experts, profusely illustrated, and published under the sponsorship of the Wildlife Management Institute. The present volume deals with the 150 species of trees that the layman is most likely to encounter. These are grouped on the basis of leaf shape, and a brief key enables the reader to identify each of the groups. 130 colored plates illustrate the habitat and habit of each tree, as well as details of twigs, bark, buds, leaves, flowers, fruit, or seeds. There is also a short account of each species giving the principal characters for field determination and the uses; and a small range map. Brief instructions for the proper study of trees, suggestions for amateur activities and an index are also furnished.

ALBERT F. HILL

PLANT PHYSIOLOGY

PLANT GROWTH SUBSTANCES.

By L. J. Audus. Interscience Publishers, New York. $6.50. xx + 465 pp. + 42 pl. 1953.

Plant Growth Substances, by Audus, is a remarkable model of what can be accomplished in bridging the gap between a scientific review monograph and a popularization of the basic principles underlying practical methods now in use. The subject of plant growth substances is a central one in present-day plant physiology. The application of synthetic growth substances to crops is one of the most important aspects of modern chemical agriculture. These two aspects of the one subject are presented side by side, with a full exposition of the relationships between the two levels of the entire subject.

As a scientific monograph, the subject of plant growth substances is here reviewed from its beginnings through the early part of 1952 in a highly lucid, integrated, and critical fashion. Not only the effects of externally applied auxins, but every aspect of the organizing role of the natural auxin is clearly developed. The later literature is fully discussed, complete with citations, while the earlier established principles are stated in terms of the experimental conditions under which they were demonstrated. In addition to the auxins, there is included a sensible and careful presentation of the evidence for other sorts of hormones, specific organic growth factors, and natural plant growth inhibitors. Thus the flowering hormone, sex hormones of *Chlamydomonas* and of *Achlya*, specific growth factor requirements of roots, stems, leaves, and embryos, natural germination inhibitors, and some of the newer synthetic inhibitors are all discussed in considerable detail. It is most gratifying to see that throughout the book, scrupulous attention is paid to the distinction between experimentally verifiable facts, experimental results which have not been or cannot be repeated, and speculation based on preliminary evidence.

For the practicing farmer or gardener, the practical applications of this body of knowledge are all discussed in great detail. No attempt is made to recommend specific horticultural practices. However, the principles underlying all the details of practical use are expounded, so that after reading this book a plantsman would be able to use the commercial preparations with full regard for all their possible detrimental as well as beneficial effects. For the benefit of the intelligent layman, the early growth of the subject and basic principles of plant growth are explained in some detail, although these are available in other purely technical books. The extreme clarity of the writing and directness of presentation also contribute to its value for the non-scientific reader.

The only serious limitations of the book, for scientific readers, are its omissions. Essentially no consideration is given to the mechanism of auxin action, or to the biochemical processes involved in cell growth. In view of the wide audience at which the book is aimed, such an omission is very understandable, since it would require a prior development of very large parts of the field of biochemistry in order to make the discussion comprehensible to those not already familiar with it. Audus does, however, include one chapter on the chemistry of auxins, without attempting in the least to popularize, and saying specifically that it is written for chemists who are not familiar with these biologically important compounds. It may be hoped that in a future edition, Audus will attempt a similar chapter on the mechanism of auxin action on cell growth, especially since his own contributions in this field are so outstanding. In the meantime, this book will serve the present biochemical physiologist as an excellently organized, clearly presented, and critical summary of the more purely physiological aspects of the work on plant growth substances.

The most stimulating aspect of the book is the manner in which, at every step, the interrelationship is shown between specific laboratory experiments and agricultural practice. Much too often the general public fails to appreciate the need for pure research as a basis for further advances in the control over nature. Even more infrequent is an appreciation of what really goes on in experimental research. Surprisingly often, too, a research scientist will not be fully aware of the far-reaching practical importance of advances in his particular field of specialization. Audus' book should clear up any such misapprehensions

in the field of plant growth substances for once and all, by its unique balance in emphasis between the plant and its activities, the experiments by which the controlling role of natural auxins and other compounds has been demonstrated, the synthetic auxins and their effects when applied externally, and the practical economic uses of controlled applications. It is to be hoped that the book will find a wide audience among plant scientists, the better educated farmers and gardeners, and in particular in the state agricultural colleges for which it seems ideally suited.

A. T. JAGENDORF

THE METABOLISM OF ALGAE.

By G. E. Fogg. John Wiley & Sons, New York; Methuen & Company, London. $2.00. x + 149 pp.; ill. 1953.

The term algae covers a somewhat heterogeneous group of green plants, and a study of their metabolism is of considerable interest from the viewpoint of comparative biochemistry. This monograph by Fogg has assembled a large number of facts about the unusual flexibility of various algae in the details of their metabolic pathways. Particular attention is paid to the photosynthetic and chemosynthetic apparatus of algae, and the ways in which these diverge from the more rigid patterns of higher plants. Thus the presence of accessory pigments which absorb light energy that is transferred to chlorophyll and is used for photosynthesis, the presence of the oxy-hydrogen reaction, and the photoreduction of hydrogen and hydrogen sulfide are all discussed in some detail, in addition to a brief but carefully organized coverage of the aspects of photosynthesis applicable to all plants. Assimilation of organic carbon, and of organic and inorganic forms of nitrogen, are given similar treatment. Because the book is so brief and tightly organized, it will not be especially understandable without some previous background in biochemistry.

Of much interest and possibly of great future importance are the facts presented in the chapters on The Products of Metabolism and on Growth and Metabolism. Among the various algae it is possible to find an extremely varied assortment of polysaccharides, both as food reserves and cell wall constituents, many of them being entirely unique. The biochemistry of the sugars will not be complete until the structures and modes of synthesis of these substances are elucidated. Evidently many algae have only low rates of secretion, and the large amounts of materials accumulated during growth can be changed radically by manipulation of the environment. This control could be an important factor in the use of algae as food sources, which may become more and more necessary as the human population increases beyond the limits of the world food supply. Fogg's concise monograph will be most useful in focusing attention on the known and the still unexplored fundamental biochemical properties of algae—and only with further advances in this area can economic use of the algae become a reality.

A. T. JAGENDORF

A LABORATORY MANUAL FOR ELEMENTARY PLANT PHYSIOLOGY. *Second Edition.*

By Victor A. Greulach. Burgess Publishing Company, Minneapolis. $2.25 (paper). 85 pp. 1952.

Eighty-five simple experiments designed for a one- or possibly two-semester course in plant physiology. Emphasis is on work with living plants, and all the prominent principles of physiology are illustrated. Biochemical aspects are barely touched upon. The manual will be most useful for courses in small colleges without extensive facilities.

A. T. JAGENDORF

ECONOMIC BOTANY

CROP VARIETIES. *Varieties of Cereals, Flax, Potatoes, Beans and Field Peas. Farmer & Stock-Breeder Publications.*

By H. Hunter. E. & F. N. Spon, London. 21s. xiv + 224 pp. + 14 pl. 1951.

In recent years many new varieties of crop plants have been developed by plant breeders in an attempt to increase production, to obtain products of definite quality for some specific commercial purpose, and because of the greater suitability of certain varieties to the changes in agricultural practices brought about by mechanization.

This book discusses the superior varieties of the more important crop plants of Great Britain and Ireland, as demonstrated by field trials and by qualitative determinations, both in relation to their agricultural demands and their commercial requirements. Although concerned primarily with conditions outside the United States, this book should be of interest to American botanists, in that it summarizes the plant-breeding research that has taken place in the past in England, and presents an over-all picture of the present status of the science.

An introductory chapter deals with the nature and underlying general principles of plant breeding, particularly those concerned with the improvement of varieties by selection and hybridization. Barley (chiefly malting barley), wheat, and oats are considered in considerable detail under such headings as soil and climatic requirements, experimental investigations, the most outstanding varieties, their principal qualitative and quantitative characteristics, hybridiza-

tion, and seed selection. Rye, field beans, field peas, and flax are similarly treated, but less fully.

The increasing importance of the potato in Great Britain, however, is reflected by the large amount of space devoted to this crop. All aspects of potato-growing are covered, such as its introduction into Europe, its centers of origin, the wild species involved, varieties cultivated, utilization, quality, diseases, improvement, seed production, and certification.

There is also a chapter on pure seed and schemes for seed certification, emphasizing the desirability of such a program, the sources of botanical impurities, and the production and maintenance of pure seed.

Each chapter has a selected list of references and there is an adequate index.

ALBERT F. HILL

THE AMERICAN GRASS BOOK. *A Manual of Pasture and Range Practices.*

By Sellers G. Archer and Clarence E. Bunch. University of Oklahoma Press, Norman. $3.95. xxii + 330 pp.; ill. 1953.

Grass has always been, and probably always will be, an indispensable form of plant life. The proper planning and efficient management of pastures and meadows is, therefore, of the utmost importance. In recent years there have been many changes in grass agriculture: improvements in techniques and machinery, new developments in planting, and new adaptations of grasslands and legumes.

The authors of this very readable and informative book are specialists in their field, with some 35 years of experience in soil conservation work and pasture and range development. *The American Grass Book* evaluates the various techniques and brings together in a most comprehensive manner the proper methods for establishing grassland for profit, for proper land use, and for the prevention of soil erosion. Although intended primarily for the guidance of farmers, ranchers, and land owners, this work will enable anyone who is interested to acquire a much better understanding of the new grass agriculture.

The book is divided into seven parts: (1) Permanent Agriculture Based on Grass—dealing with the importance of grass, the history of our native grasslands and their exploitation, the role of grasses in soil development, and in erosion and flood control. (2) Planting Grass—a section devoted to planning, preparation, and cultivation, with chapters on the change to grassland; choosing the grass that fits the farm; using the land that fits the grass; preparing the land; planting operations; and planting Bermuda Grass. (3) Management of Grasslands—concerned with native pastures and ranges, tame pastures and irrigated pastures. The basic principles of "take half and leave half," which assures an efficient food-manufacturing plant; and the maintenance of an adequate supply of moisture and nutrient materials are constantly emphasized. (4) Seed Production—a discussion of seed sources, cleaning, storage, and marketing. (5) and (6) Individual Grasses and Legumes—detailed information concerning the characteristics, distribution, adaptation, use, seeding methods, management, and harvesting of 90 species and varieties of grasses and 34 legumes. (7) Pasture and Hay Mixtures—utilizing both grasses and legumes.

The book is well printed and illustrated with 166 photographs, several diagrams, charts, and tables, and 53 maps that show the areas of major and minor use of various species in the establishment of pastures, ranges, and meadows. There is also an extensive bibliography and an adequate index.

ALBERT F. HILL

WEED CONTROL. *Second Edition.*

By Wilfred W. Robbins, Alden S. Crafts, and Richard N. Raynor. McGraw-Hill Book Company, New York, Toronto, and London. $8.00. xii + 503 pp.; ill. 1952.

The first edition of this book, by the same authors, appeared in August, 1942, since when herbicides have undergone an explosive change in importance. This is primarily due to the discovery of 2-4-dichlorophenoxyacetic acid as a selective weed killer. The results from this new compound have been truly revolutionary. In fact, it has so altered the approach to weed-killing that, as the authors say, "In short, it seems safe to say that weeds as pests are rapidly being accorded the attention that has long been given to insect pests and plant diseases." The reference, of course, is to chemical "attention." For the first time in history, farmers are beginning to glimpse a control of weeds vastly simplified by the application of chemicals. This will reduce the backbreaking toil that has been the heritage of farmers since herders settled down to agriculture. It almost seems time for the classical poem, "The Man with the Hoe," to be retitled and rewritten, "The Man With the Squirt-Gun."

This is not a book on the physiology and biochemistry of the action of chemical compounds on plants, but a practical "cookbook" sort of treatise which deals with what to use, when, where, and how, together with a very small amount of why. It deals primarily with the chemical control of weeds, although there are a few chapters on such methods as tillage and the biological control of weeds. Chapter 9, however, seems to stand alone as a very technical discussion of electron shells and structural formulas of synthetic compounds.

For those who are concerned with the ways and means of controlling weeds in agricultural crops by means of chemicals, this is a very important book.

JAMES G. HORSFALL

CHEMICAL PROCESSING OF WOOD.

By Alfred J. Stamm and Elwin E. Harris. Chemical Publishing Company, New York. $12.00. x + 595 pp.; ill. 1953.

The object of this book, in the words of its authors, "is to assemble all available information on the chemical processing of wood by both conventional and new methods to produce modified wood products, pulp products, and various derived chemical products." The more recent developments are emphasized.

The book, the authors point out, was written primarily for chemists and engineers interested in the chemical processing of wood, but it is also suitable for use as a textbook, and is of interest to business men. An effort has been made to present the difficult technical material as simply as possible. Readers interested in a more detailed treatment of any phase of chemical utilization of wood are directed to extensive bibliographies at the end of each chapter.

These are the stated objectives in assembling this information. How well they have been attained depends on the use the reader expects to make of this book and on his previous acquaintance with the material presented in it. The volume is a fine general reference book. Certainly there is no other text in the English language that brings together such a wealth of authentic information on a very complex phase of wood utilization. The presentation is lucid, and the style extremely readable. The authors, both recognized authorities in the field of wood chemistry, have drawn freely on their own long association with the experimental work in wood chemistry at the United States Forest Products Laboratory.

The first 5 chapters are devoted to presentation of background material essential to a fuller understanding of the principles underlying the chemical processing of wood. The chemical and physical properties of wood are discussed, with the emphasis on those which help to explain the nature of wood as a raw industrial material. The brief but concise discussion of the surface properties of wood is especially excellent. The balance of the book is devoted mainly to a brief but factual treatment of the chemical processes that utilize wood as a raw material. In addition, a number of products of a chemical nature made from wood or obtained from living trees are also mentioned.

Whether this book, "written primarily for chemists and engineers," will satisfy either class of technical men may well be questioned. For instance, a total of only 50 pages is devoted to an accurate but, of necessity, encyclopedic treatment of pulp and paper manufacture. On the other hand, almost 70 pages are allotted to the very interesting but at present economically relatively unimportant subject of modified woods. One wonders why the authors included such topics as air and kiln drying, tree exudates, particularly rubber and maple syrup, in a book on the chemical processing of wood. Perhaps the space given to these and similar items could have been more effectively used for a more detailed treatment of the major phases of chemical utilization of wood. It is unfortunate that in the otherwise very helpful chapter on Wood as Chemical Raw Material, the authors have chosen to revive the oft-discredited timber shortage scare. Without engaging in a lengthy rebuttal, it will suffice to say that the same dire predictions were heard more than 50 years ago, only to be proven wrong time and time again.

This book fills an important gap in the technical literature on wood. For those who intend to broaden their understanding of nature's most important gift to mankind, it is a book of great significance. For technically trained men this is a useful general reference volume, authentic as far as it goes, and a good starting point for a more thorough pursuit of the subject.

ALEXIS J. PANSHIN

GENERAL AND SYSTEMATIC ZOOLOGY

TRAITÉ DE ZOOLOGIE. *Anatomie, Systématique, Biologie. Tome I, Fascicule II. Protozoaires: Rhizopodes, Actinopodes, Sporozoaires, Cnidosporidies.*

By Pierre P. Grassé. Masson & Cie., Paris; [Walter J. Johnson, New York]. 9,935 fr. (cloth); 9,215 fr. (paper). 1160 pp. + 2 pl.; text ill. 1953.

This second part of Volume I of the *Traité de Zoologie* continues the account of the Protozoa that was begun in the first part of the Volume. The first part disposed of the flagellates, and this second part is devoted to the rhizopods and sporozoans. The ciliates will occupy the whole of Volume II. The present volume conforms to the same high standards as the previous ones, being printed on good paper in readable type and abundantly illustrated with clear figures in black and white. It will be an indispensable aid to all advanced students of protozoology.

Probably the scheme of classification adopted will prove of the most general interest. As in the preceding volume on the Protozoa, the rank of many groups is raised; what are usually considered orders here become classes, and classes become subphyla. In the preceding volume it was briefly stated that the phylum ("embranchement") Protozoa would be subdivided into 5 subphyla ("sous-embranchements"): Rhizoflagellata, Actinopoda, Sporozoa, Cnidosporidia, and Ciliata. The difficulty of separating by definition the flagellates and rhizopods is here evaded by uniting them into one subphylum Rhizoflagellata, subdivided into two superclasses Flagellata and Rhizopoda. As the Flagellata were treated in the first fascicle, the present fascicle begins at once with the superclass Rhizopoda. The term Rhizopoda is used, however, in a new and restricted sense to include only the naked and shelled Lobosa

and the Foraminifera. The term Lobosa is elevated to the rank of class, synonymous with Rhizopoda, and the three groups just mentioned become orders. The naked Lobosa, or Amoebaea, are written up by the late E. Chatton, the shelled Lobosa, or Thecamoebaea, by G. Deflandre, and the Foraminifera by J. Le Calvez. The treatment is thorough, with special attention to mitotic processes and the intestinal amoebae. The colored plate that accompanies the shelled Lobosa appears of little value. The account of the Foraminifera includes extinct forms, with many figures of evolutionary relationships.

The subphylum Actinopoda includes the 3 classes Acantharia, Radiolaria, and Heliozoa. Whereas the group Actinopoda has long been recognized by protozoologists, raising it to a high rank distinct from other rhizopods and splitting the Radiolaria are perhaps novel. The desirability of separating the Acantharia from the other Radiolaria appears questionable. The statement in the text that the two groups have only the pseudopod type in common seems inaccurate, inasmuch as the Acantharia also possess a sort of central capsule. The Mycetozoa are treated as an order of uncertain position, but possibly to be appended to the Flagellata. The chief authors of the Actinopoda section are G. Trégouboff and G. Deflandre.

The separation of the former Sporozoa into 2 groups, the Telosporidia, or Sporozoa proper, and the Cnidosporidia, has already met with general approval among protozoologists, although one may question the desirability or necessity of carrying the cleavage to the rank of subphylum. The Sporozoa in the restricted sense includes the classes Gregarinomorpha, Coccidiomorpha, and Sarcosporidia, mostly written by P. Grassé, with the class Haplosporidia, by M. Caullery, appended to the subphylum, and followed by a long list of forms of uncertain position, including the *Babesia-Theileria-Anaplasma* group of parasites under the new name, Order Babesioidea, by R. Poisson. The Coccidia are properly united with the Haemosporidia under the class Coccidiomorpha and the account of the Haemosporidia, by R. Poisson, is accompanied by the inevitable colored plate of the malarial parasites. The Cnidosporidia includes the 3 well-established orders, Myxosporidia, Microsporidia, and Actinomyxidia, plus some doubtful forms, all handled by R. Poisson.

It appears probable that the general taxonomic treatment adopted in this volume will find wide acceptance, probably with some scaling down of the ranks. The treatment of these groups is the most extensive now available within the confines of a single volume, and as such deserves the gratitude of zoologists throughout the world. Even the most obscure forms are handled, and the seeker after information will not be disappointed in any regard. Even the defect of previous volumes with regard to documentation is here somewhat remedied, for there are considerable bibliographies appended to the various chapters, especially concentrated on recent literature.

L. H. HYMAN

PROTOZOOLOGY.

By R. P. Hall. Prentice-Hall, New York. $10.00. iv + 682 pp.; ill. 1953.

Protozoology, by Hall, has many desirable features. One outstanding feature is the treatment of some general principles and concepts related to protozoology prior to the presentation of minute details which must accompany the studies of classification, heredity, physiology, etc.

The first 2 chapters are on General Morphology, and Reproduction and Life Cycles. The initial remarks of the author are directed toward the endless controversies dealing with "border-line" organisms (plant or animal) and the cell theory (acellularity versus unicellularity). These comments are followed by descriptions of organelles, cytoplasmic inclusions, pigmented bodies, nuclei, cysts, colonies, etc., that are characteristic of the various types of protozoa. All this serves as a sound foundation for appreciation of the chapters on classification which follow.

An interesting review of the history of the early classification of protozoa mentions the erection of the phylum Protozoa by Hill in 1752, the contributions of Miller (1786), Ehrenbert (1838), Kent (1882), and Bütschli (1889). The history of the taxonomic systems of the 20th century includes the systems of Calkins, Doflein, Kudo, and Jahn and Jahn. The author employs a consistent system of classification throughout his book. This should be received favorably. He has modified the system of Jahn and Jahn by using the following endings for different taxonomic groups:

phylum, —a;	sub-phylum, —a;
class, —ea;	sub-class, —ia;
order, —ida;	sub-order, —ina.

The chapters on classification are supplemented with large numbers of line drawings, with magnification references.

Following the classification of the Protozoa are chapters on their physiology and heredity. The first of these chapters contains general concepts regarding their nutrition, growth, metabolism, locomotion, and responses to stimuli. The information pertaining to locomotion describes how the organisms move (e.g., mode of beating of cilia) but does not mention the theories regarding causation and operation. The chapter on heredity includes information pertaining to mating types, strains, plasmagenes, and antigenic substances. Naturally, most information stems from the research on the ciliate *Paramecium*.

The 5 final chapters deal exclusively with parasitic protozoa, and are entitled: Host-Parasite Relationship; Protozoa of the Digestive and U-G Tracts; Blood

Flagellates; Malaria; and Immunity and Resistance. The information contained in the chapter on Immunity and Resistance may serve to introduce students to the possibility of employing immunological-antigenic responses as a basis for classification. The section on parasitic protozoa also includes information pertaining to the diagnosis, therapy, and duration of infections.

It appears that (1) descriptions of the life-cycles of parasitic protozoa should have been included and contrasted with the cycles of free-living forms, thus developing the biological principle of adaptation; (2) the benefit of Hall's valuable experience relative to the physiology of protozoa could have been better utilized by enlarging the chapter on Physiology at the sacrifice of such information as the diagnosis and therapy of diseases, since information on the physiology of protozoa is still too scattered in the literature, whereas there are many texts containing information on protozoan diseases; and (3) the important biological principle of evolution has been neglected. Theories pertaining to the origin of sexuality and multicellularity are lacking, as are theories pertaining to phylogenetic relationships.

In view of the extensive bibliography (2,715 references), consistent classification, and treatment of specialized topics such as physiology, immunity, and heredity, Hall's book will be appreciated by student, teacher, and researcher.

ROLAND M. NARDONE

LEHRBUCH DER PROTOZOENKUNDE. *Eine Darstellung der Naturgeschichte der Protozoen mit besonderer Berücksichtigung der parasitischen und pathogenen Formen. Part 1: Allgemeine Naturgeschichte der Protozoen. Sixth Edition.*

By Franz Doflein; continued by Eduard Reichenow. Gustav Fischer, Jena. DM 21. (paper). 408 pp.; ill. 1949.

From its first appearance Doflein's *Lehrbuch der Protozoenkunde* became the standard advanced treatise on the Protozoa. The fifth edition, revised by Reichenow, and appearing in 1929, was a splendid achievement that greatly surpassed other available general works on the Protozoa, although it was less thorough on the parasitic forms than Wenyon's *Protozoology*, which appeared at about the same time, and remained for years the leading reference for advanced students. Now there is available the first part of a sixth edition, also revised by Reichenow, equivalent to the section *Allgemeine Naturgeschichte der Protozoen* of the previous edition. The systematic discussion, which formed the second part of the original work, is presumably to appear later as a separate volume.

The present volume is quite disappointing as a presumed revision, as it differs in fact but little from the fifth edition. The plan of organization of the fifth edition is closely followed, and the same topics are discussed, occasionally with a slight rearrangement. Many paragraphs are repeated verbatim, and although many others have been reworded, the essential information contained therein is for the most part unaltered. Nearly all of the familiar figures of the fifth edition appear here also, with only a very few omissions and with the addition of a very few new figures, mostly from Reichenow's own work. As the new edition is printed on very cheap paper, the reproduction of the figures is poor and very inferior to the fine reproduction that was a feature of the fifth edition.

Although the bibliography lists a number of titles from the work of the last 20 years, many of these articles are given little, if any, consideration in the text. New material was noticed in the following topics. There is an enlarged discussion of protozoan metabolism, especially as regards the use of carbohydrates by trypanosomes and other parasitic Protozoa and the role of vitamins in protozoan nutrition. Some recent literature has been incorporated into the discussion of respiration and in the field of behavior there is included the work of Mast and of Mainx and Wolf on reactions to light and of the Alverdes school on the learning capacity of the Protozoa. Cleveland's important work on mitosis is considered, with reproduction of some of his figures. The discussion of sexuality has been reasonably modernized with accounts of endomixis and related phenomena and inclusion of Moewus's work on sexual differentiation and the production of carotenoid sexual stuffs in chlamydomonads. The closing section on culture methods has been modernized and will no doubt prove useful. On the other hand, there is scarcely any discussion at all of many topics on which there exists a large modern literature. There is no reference to recent work on amoeboid and flagellate movement; the discussion of the silver line system or infraciliature, on which a large number of articles have been written in the last 20 years, is limited to one short paragraph accompanied by a figure so poor and dark as to be almost indiscernible; and no reference is made to modern work on the nutritional requirements of Protozoa.

There is a good bibliography, including many titles that have been published since the previous edition, but there is no index; however, from the table of contents it is fairly easy to locate the discussion of any desired topic. Despite its deplorable lack of modernization, this work still remains the best general account of the Protozoa and is calculated to give advanced students a good foundation in the subject, providing they bear in mind the necessity of augmenting the text with outside reading on articles that have appeared in the last 20 years.

L. H. HYMAN

HOW TO KNOW THE SPIDERS. *Pictured-Keys for determining the more common spiders, with suggestions for collecting and studying them.*

By B. J. Kaston and Elizabeth Kaston. Wm. C. Brown Company, Dubuque. $3.00 (cloth); $2.25 (paper). vi + 220 pp.; ill. 1953.

This valuable little book is the successful result of a highly interesting and extremely difficult project—that of introducing the spiders, a large and little known order of animals, to the amateur naturalist and the general biologist alike.

Leaving out the Micryphantidae, which are too small and too difficult for any but the specialist, together with a few other uncommon families, here are illustrated keys to 40 spider families, 190 genera, and 271 species native to this country. The making of keys is the acme of taxonomic art, and Kaston, as he demonstrated in his *Spiders of Connecticut*, is a master at it. Mrs. Kaston's accurate and beautiful drawings, of which there are 552 in the book, are an integral part of the keys; and it is good to see her in the status of joint author. She is known among araneologists throughout the world as the leading artist in this field.

This is a low-priced book intended for, and well deserving, a wide distribution. It is an offset job, but one that is exceptionally clean and sharp, and the common disadvantages of the process are so little in evidence as to be no hindrance at all to the fundamental aims of the book.

In addition to the keys and to the combined index and illustrated glossary (a very practical novelty), Kaston, in the introductory sections, has written concisely and most interestingly about the place of spiders in the order of nature; about their ways, food, courtship, reproduction, and anatomy; how to collect and preserve them; and how to use the keys and make identifications.

This book is one of a Pictured-Key Nature Series now running to 14 titles. A very useful and practical set it is, particularly for all the teachers and practicing biologists who have to answer questions about the common plants and animals in the world around us.

WALKER VAN RIPER

STRUCTURE AND FUNCTION OF THE GENITALIA IN SOME AMERICAN AGELENID SPIDERS. *Smithsonian Misc. Coll. Vol. 121, No. 4. Pub. 4101.*

By Robert L. Gering. Smithsonian Institution, Washington. 80 cents (paper). iii + 84 pp.; ill. 1953.

After supplying a brief historical résumé, Gering considers the morphology of various structures making up the male and female genitalia of these spiders. Each part is taken up in great detail. The morphology section is followed by an account of the courtship behavior, and of the action of the copulatory mechanism itself. While most emphasis is given to various species of the genus *Agelenopsis*, comparisons are presented not only with other members of the same family, but also with a number of spiders from other families.

Some space is devoted to a discussion of the "lock and key concept," which has been favored by a number of araneologists (including Petrunkevitch, whom Gering appears to have overlooked in this connection). While admitting that in many spiders there are structures in the male which exactly correspond in size and shape to certain copulatory structures in the female, the author concludes that for the genus *Agelenopsis* "there appears to be little if any mechanical preclusion of cross mating," and that the "lock and key concept" is poorly supported by his studies.

Disturbing was the repeated use throughout the paper of the orthography "spermathecum" and "spermatheca," for the singular and plural, respectively, of what should have been "spermatheca" and "spermathecae." Nevertheless, those interested in the sexual biology of spiders will find in Gering's work a wealth of detailed data.

B. J. KASTON

PROCEEDINGS OF THE XTH INTERNATIONAL ORNITHOLOGICAL CONGRESS, *Uppsala, June 1950, under the presidency of Alexander Wetmore.*

Edited by Sven Hörstadius, General Secretary. Almqvist and Wiksell, Uppsala. 35 Sw. Kr.; £2 8s. 3d.; $6.75 (paper). 662 pp. + 1 pl.; ill. 1951.

[Preferably obtained by sending 35 Sw. Kr. to Professor Sven Hörstadius, Zoologiska Institutionen, Uppsala (bank: Svenska Handelsbanken, Uppsala), but also from booksellers, through Almqvist and Wiksell, Uppsala.]

For one week in June, 1950, over 300 varieties of avian experts from 27 countries of the globe flocked together in ancient Uppsala University (founded in 1477) for the Xth International Ornithological Congress, the first after an interval of 12 years, the IXth Congress having been held in Rouen in 1938. What was formally said and done, and what species of birds were observed during 10 field excursions before and after the Congress to the various provinces of Sweden, including the Lappland and the islands of Öland and Gotland, are recorded in this thick volume. The formal sessions began with an address of the President, Alexander Wetmore, on prehistoric birds whereby the reader clearly gains an insight into the advances made over a period of 17 years (1933–49) into the complexities of unravelling the probable steps in the evolution of modern birds. The second paper on the program, by Sven Hörstadius, is an intriguing account of the early history of the development of ornithology in Sweden. It is convincingly brought out that Olof Rudbeck the younger was the founder of Swedish ornithology, for

not only did he lecture on birds, but his idea of the division of birds is clearly reflected by the numerical order of his collection of plates. Furthermore, we learn that, through Rudbeck's lectures at Uppsala, Carolus Linnaeus received instruction on the structure and habits of birds during 1728 and 1729. It is not surprising, therefore, that the first zoological work of Linnaeus was devoted to birds ("A Catalogue of all Swedish Birds, arranged in a new system according to the construction of their beaks").

Most of the remaining papers are somewhat abbreviated reports on new findings or ideas on a wide variety of topics—all, however, logically arranged under topical headings such as Evolution and Systematics, Bird Migration and Orientation, Bird Behaviour, and Population Dynamics. In each of these four "central domains" of ornithology, however, an unabridged survey or review paper is presented. These are: (1) Speciation in Birds, by Ernst Mayr; (2) Bird Migration and Orientation, by R. Drost; (3) Bird Behaviour, by N. Tinbergen; and (4) Population Ecology in Birds, by David Lack. The last mentioned title is the newest of the four subjects reviewed at the Congress and seems to be the first synthesis of ideas on the subject. The impact of the advances in other branches of biology is clearly evidenced in this volume. It contains a fund of valuable new information on the biology of birds from almost every point of view.

B. H. WILLIER

THE BIRDS OF CRATER LAKE NATIONAL PARK.

By Donald S. Farner. University of Kansas Press, Lawrence. Free upon request. xi + 187 pp. + 8 pl. + 1 map. 1952.

There were four objectives in preparing this volume on the birds of Crater Lake: to serve as an inventory of the birds of the Park; to provide the naturalist organization of the Park with the basic information necessary to their duties; to provide the interested visitor to the Park with a source of information on the birds; and to contribute to a better understanding of the habits and distribution of the birds of the high Cascades. These four objectives have been well fulfilled. Farner gives a brief summary of the ornithological history of the area and a description of the Park in terms of its geology and habitats, including various ecological communities. The annotated list discusses the status of the species within the Park and a résumé of records, both of collected specimens and of field observations. Subspecific determinations, when available (collecting within the Park is prohibited), are included. The result is a carefully selected list. A supplementary list adds those forms which occur close to but not yet actually within the Park, and others whose status appears to be problematical. The book is indexed and illustrated with views of the Park. Its main shortcoming is the paucity of information on the winter status of the birds. Students of bird behavior will be interested to read about the swimming bald eagle (p. 37) and the flycatching antics of an Arctic Three-toed Woodpecker (p. 66).

HENRI C. SEIBERT

BIRDS AND MAMMALS OF THE SIERRA NEVADA, *With Records from Sequoia and Kings Canyon National Parks.*

By Lowell Sumner and Joseph S. Dixon. University of California Press, Berkeley and Los Angeles. $7.50. xviii + 484 pp. + 28 pl. + 2 folded maps. 1953.

The title of this book is somewhat misleading, for the distributional records pertain only to the Kings Canyon and Sequoia National Parks. The book itself is the latest in the National Park Fauna Series, following such notable titles as Murie's *Wolves of Mount McKinley* and *Ecology of the Coyote in the Yellowstone*. The information included is the result of 37 years' accumulation of data on the part of the personnel of the parks' staff and of the University of California. In all, 161 species of birds and 65 of mammals are recorded as being either permanent or seasonal inhabitants of the area. Such rarities as the California condor, the wolverine, and the fisher still occur here, making the faunal list probably more nearly like that which existed during primitive times than that of any other part of the Sierras. The book is well illustrated, with numerous photographs of birds and mammals, as well as scenes typical of the various life zones found in the parks. There are also 8 excellent color prints of paintings by Allan Brooks, 3 of birds and 5 of mammals. The 2 maps of the parks, one topographic and one ecological, unfortunately do not include many of the place names mentioned in the text.

The authors present an excellent case for the existence of national parks, as well as for the proper management and use of all lands, both public and private. The sequence of overgrazing, erosion, and recovery, as seen in one part of Kings Canyon, is well illustrated in a series of photographs. In the text each species is treated under 3 headings; description, habits, and park records. Without sacrificing scientific accuracy, the information has been organized in a way that will appeal to the lay public for which the publication was especially designed.

BRYAN P. GLASS

AVIAN SYSTEMATICS AND EVOLUTION IN THE GULF OF GUINEA. *The J. G. Correia Collection. Bull. Amer. Mus. nat. Hist., Vol. 100, Art. 3.*

By Dean Amadon. American Museum of Natural

History, New York. $1.00 (paper). Pp. 393–452 + 4 pl.; ill. 1953.

This report is based on a collection of birds from the islands of Fernando Po, Principe, and São Tomé, made by José Correia and his wife in 1928 and 1929. The island of Annobon is frequently alluded to, and is included in, the island by island list of birds. Only resident, non-marine birds are considered. The former island was surely connected to the mainland in the not too distant past, whereas the others appear to have been always separated. These views are supported by the bird fauna; Fernando Po has an essentially continental biota, and the others have an insular character. The degree of endemism, expressed in percentages, for genera, species, and species and subspecies combined is for Fernando Po 0, 0.75, 34; for Principe, 4, 17, 47; for São Tomé, 7, 30, 57. The evidence points to independent colonization from the mainland for all islands. Amadon synonymizes some insular races with the continental forms, recognizes others as distinct, and describes 5 new races, 2 of them from Fernando Po, 1 from Principe (stated as all three from Fernando Po in the summary), and 2 from the mainland of West Africa. Larger size and longer bill are often noted on the island forms, but no adequate explanation of this is available. No definite trend in plumage color is noted, although feather texture is often softer and more lax on the islands.

HENRI C. SEIBERT

A STUDY OF ASIATIC LARKS. *Notes from the Walter Koelz Collections, No. 11. Bull. Amer. Mus. nat. Hist., Vol. 97, Art. 5.*

By Charles Vaurie. American Museum of Natural History, New York. $1.25 (paper). iv + pp. 435–526 + 17 pl.; text ill. 1951.

The larks from Iran, Afghanistan, and India are critically reviewed in this bulletin. The wealth of material that Vaurie had available for study enables him to conclude that 10 genera exist within the geographical scope of the study. Convergence is great, affecting size and shape of the bill, pattern of plumage, size and shape of the hind claw, feathering of the nostrils, relative sizes of wing feathers, bones of the skull, and other characters used as generic indicators. On the other hand, the species appear to be quite distinct, the pattern of the plumage and the shape of the wing being excellent diagnostic characters. Several forms believed to be conspecific are now shown to be separable. The ecology of the larks is briefly discussed, mostly by listing preferred habitats. Cryptic coloration is found to be at its best in Africa but is not pronounced in Iran. Most larks have one molt, but some may have an incomplete postjuvenal molt, or a partial prenuptial molt, or both, and the first winter plumage may be different. The main part of this report is devoted to the description of the genera and species—including nomenclatural and distributional notes—and other pertinent material. Tables and maps are included.

HENRI C. SEIBERT

THE SCIENCE OF ZOOLOGY.

By James C. Perry. The Bruce Publishing Company, Milwaukee. $6.50. xiv + 709 pp.; ill. 1952.

LABORATORY MANUAL FOR THE SCIENCE OF ZOOLOGY.

By James C. Perry. The Bruce Publishing Company, Milwaukee. $1.45. 160 pp.; ill. 1952.

It is the intention of the writer to present zoology as a science in its own right, and not as a preliminary introduction to specialized fields. In going through the text a comprehensive coverage is noted. Any beginning student who masters most of the contents will certainly have a broad background in zoology. There are 24 chapters. The first 4 include an introduction and 3 chapters on the cell—its structure, origin, and function. The 5th chapter has been cleverly inserted to broach the topic of classification and to describe the phylum Chordata. After this introduction, the anatomy and physiology of the vertebrates are taken up in the usual sequence. Starting with chapter 14, the Animal Kingdom is described, phylum by phylum, and then the text closes with chapters on genetics, ecology, and evolution. The illustrations are not so fancy as those in other recent text books, but are sound, and many have been selected on the basis of what the student is likely to see in the laboratory. Several misspellings and other minor errors were noted which undoubtedly will come to the writer's attention. Of more importance is the question of how much of this material can be learned and assimilated by the student whose background in science is weak, especially in chemistry. Much of the physiology seems to be above the elementary level, and then to superimpose the embryology and comparative anatomy of the organs, with all their attendant terminology, indeed makes for a rather awesome dose. The topic of ecology is treated unevenly; the chapter on evolution is confusing and not up to the standards of the other chapters. Each chapter is concluded by a summary and a list of questions.

The laboratory manual closely follows the textbook and gives explicit directions for various laboratory observations, drawings, and experiments. It, too, is most comprehensive.

HENRI C. SEIBERT

ZOOLOGY LABORATORY MANUAL *for Courses of One Semester or One Quarter.*

By A. M. Winchester. Wm. C. Brown Company, Dubuque. $2.00 (paper). vi + 152 pp.; ill. 1950.

The present guide to a college introductory zoology course may be summarized briefly: it is intended for one semester; it contains 16 chapters, starting with scientific method, the microscope, the cell, thence through a survey of 10 phyla, followed by the physiology of the chordate body, representative chordate types, genetics, and embryology. There are instructions for observations and dissections in each chapter. The second part of the manual contains the work sheets for each of the above chapters, and these sheets are intended to be torn out. The latter contain questions to be answered, drawings to be completed and labeled, and blank areas for original drawings. The work sheet on physiology is long, involving studies on nerve and muscle action, heartbeat, sensory organs, enzymes, respiration, blood, urine, and gametes. Although designed to accompany the author's textbook, the manual can be used with others. It is a shame that the misspelling "Psysiology" escaped the editor's eye, since it occurs in embarrassingly conspicuous places, like the chapter headings.

HENRI C. SEIBERT

ECONOMIC ZOOLOGY

FICHES D'IDENTIFICATION DU ZOOPLANCTON No. 30–40. *Conseil Permanent International pour l'Exploration de la Mer, Charlottenlund Slot, Dänemark.*

Published under the direction of P. Jespersen and F. S. Russell. Andr. Fred. Høst & Fils, Copenhague. Kr. 12.00 (paper). Sheets 30 to 40 incl.; ill. 1951.

Nos. 30–31 are keys to hydromedusae, by F. S. Russell. Nos. 32–40 are keys to calanoid copepods, by the late G. P. Farran, revised by W. Vervoort.

SURVEY OF THE DOMESTIC TUNA INDUSTRY. *Special Scientific Report: Fisheries No. 104.*

By A. W. Anderson, W. H. Stolting, and Associates. U. S. Department of The Interior, Fish and Wildlife Service, Washington. Paper. xv + 436 pp.; ill. [No date].

INSECT, FUNGUS AND WEED CONTROL.

By E. R. de Ong. Chemical Publishing Company, New York. $10.00. 400 pp.; ill. 1953.

Insect, Fungus and Weed Control compiles a wealth of information dealing with the science of controlling pests. Most of the text is devoted to insecticides and fungicides, in keeping with the author's training and experience, which has been in the field of entomology and plant protection. Only one chapter is devoted to herbicides.

References at the end of each chapter are very useful, should one care to consult the original reports. However, the most recent references are dated 1951. Because it is impossible to keep up to the minute on all phases of this rapidly expanding field, the author has included as his final chapter a brief résumé of the latest developments that have been reported since the main portion of the text was written in 1951.

The author suggests the term "biocide" to replace the firmly entrenched term "pesticide," principally because it has the same stem as "biology" and secondly because the word "pest" from which "pesticide" stems connotes to some minds pestilence or the diseases of man. He feels that "pesticide" might be confused with medicines, antibiotics, and drugs. It is doubtful that many persons these days consider human bacterial or virus diseases as pests. The term "biocide," moreover, is all-encompassing and would not be strictly limited to fungicides, insecticides, and herbicides. It is interesting to note that the author uses the terms "pest" and "pesticide" in the text and does not adopt his own suggested term.

The author has presented a great deal of information on the physical and chemical properties of active compounds and diluents. This should be of great value to formulators. His treatment of the effects of insecticides on beneficial insects is interesting. He states that many widely used new insecticides are less harmful to beneficial insects than the older insecticides, such as calcium arsenate.

The text contains a very complete coverage of insecticides and fungicides with full chemical name, common name, insect species or fungus upon which they are effective, physical and chemical properties if they are unusual, and methods of application. The coverage of herbicides is somewhat less complete.

The book should be especially valuable to the county agent and extension specialist who must have a thorough knowledge of all aspects of the latest developments in the pesticide fields. It is of less value to the research chemist or biologist. The author does not present a discussion of the mechanism of action of the pesticides. There is some repetition from chapter to chapter, but perhaps this is necessary if the chapters on control of insects in the forest, in the household, on livestock, and in industry are to stand by themselves. A number of good plates improve the text, and an extra bonus is a short discussion of rodenticides.

C. E. MINARIK

THE CHEMISTRY AND ACTION OF INSECTICIDES.

By Harold H. Shepard. McGraw-Hill Book Company, New York, Toronto, and London. $7.00. viii + 504 pp.; ill. 1951.

Insecticides have come in for extensive treatment by various authors. There are several books on the chem-

istry of insecticides, but Shepard has done one of the best extant on their action. This book, the first edition of a new text, actually follows a mimeographed edition published in 1939 under the title, *The Chemistry and Toxicology of Insecticides*. Shepard, it is to be suspected, has eliminated the word "toxicology" because of possible terminological confusion with the toxicology of compounds to human beings.

The author's basic breakdown of the subject is chemical rather than according to action. He deals with arsenical compounds, sulfur, copper, pyrethrum, and synthetic insecticides, for example, rather than with permeation, action on enzymes, action on essential metabolites, etc. Shepard considers each type of compound in terms of its history, the quantity consumed in America, the usefulness of the compound, and something about how it acts within the organism. As to the famous insecticide, DDT, he says, "In insects the major site of action of DDT appears to be the peripheral nervous system, including both sensory and motor nerves. Such sensory structures as the campaniform sensilla of the roach trochanter are acted upon by DDT." He goes on to say, "Two general theories have been advanced to explain the relation of chemical structure of DDT to insecticidal activity. . . . (1) that the trichloromethyl part of the molecule (similar in structure to chloroform) confers upon DDT the lipoid solubility postulated as a requirement to bring about penetration to the site of action and the parachlorophenyl groups linked by a carbon atom constitute the toxic component of the molecule. (2) The theory of Martin and Wain is based on the opposite view that (a) the parachlorophenyl grouping would be responsible for the lipoid solubility of DDT and (b) the trichloromethyl radical furnishes toxicity in relation to the amount of hydrochloric acid which is split off by dehydrohalogenation at vital centers in the organism." This book by Shepard will constitute a very desirable addition to the library of any who are concerned with the biological activity of chemical compounds.

JAMES G. HORSFALL

FOREST ENTOMOLOGY. *Third Edition. American Forestry Series.*

By Samuel Alexander Graham. McGraw-Hill Book Company, New York, Toronto, and London. $6.00. xii + 351 pp.; ill. 1952.

The thoroughly revised third edition of Graham's *Forest Entomology* is a welcome addition to the list of modern forestry textbooks. It should not be looked upon as a reference work on forest insects, but rather as a very readable presentation of principles of forest entomology, which was the title of earlier editions. The author treats his subject from the standpoint of forestry and forest ecology, not from the standpoint of entomology. It is well adapted as a textbook of forest entomology in schools of forestry. However, more complete treatment of the important forest pests would enhance its value as a reference book in the future work of forestry students. Practicing foresters need more complete reference works, such as *Forest Insects* by Doane, VanDyke, Chamberlin, and Burke, and the U. S. Dept. Agric. Misc. Pub. 657, *Insect Enemies of Eastern Forests*, by Craighead. Graham has done an admirable job of integrating the very rapid new developments in economic entomology with the established principles of forest entomology and silviculture. He has done the profession a service in pointing out the complexity of forest biology and the resulting need for careful thought and planning in any large-scale forest insect control operation.

The scope of the book has been broadened by the considerable attention paid to newer direct control procedures, including the newer insecticides and methods of application. Perhaps greater value as a reference work would have resulted from more complete treatment of the exact forestry uses for insecticides such as benzene hexachloride, chlordane, and even DDT.

The improved quality of the paper is welcome, and has made possible better reproduction of the illustrations than in the older editions. Several illustrations have been replaced by better photographs. On the other hand, several illustrations have been combined and reduced, resulting in poor definition (e.g., Fig. 36). It is unfortunate that many worthwhile illustrations have been deleted. In fact, there are only about one half as many figures as in the second edition.

The bibliography is in the same form as in the second edition, but has of course been brought up to date. A few references are difficult to find because the references are given but once, under the chapter where first cited.

The objections are minor. *Forest Entomology* deserves a place on the book-shelf of all entomologists and foresters.

JOHN G. MATTHYSSE

GLI ANIMALI COMMESTIBILI DEI MARI D'ITALIA.

By Arturo Palombi and Mario Santarelli. Ulrico Hoepli, Milan. L. 3800. vi + 348 + 2 pl.; text ill. 1953.

This is a rather unusual book that should be of interest in various fields. It is concerned with the edible animals of the marine waters around Italy, and reports about 250 species, mostly fish, but tunicates, echinoids, mollusks, and crustaceans are also included. Each species is illustrated by a photograph, accompanied by a description and a brief statement of habits and mode of capture. It is interesting to learn that a tunicate (*Microcosmus sulcatus*) is eaten in Italy, raw and whole after removal of the tunic. The gonads of 4 different kinds of sea urchins are eaten, especially

those of *Paracentrotus lividus*. Five kinds of squids and 4 kinds of octopuses are relished in Italy, but unfortunately we are not told the method of preparation. There are 2 colored plates of edible shrimps. Undoubtedly the most valuable part of the book is the list accompanying each species of vernacular Italian names and the names in the main European languages. There is a very extensive index, including all of the common names, so that at once one can find out the scientific name in the case of articles in which only the common name is given. Anyone who has tried to find out the scientific name of an animal referred to only by the common foreign name will appreciate this feature.

L. H. HYMAN

ANIMAL GROWTH AND DEVELOPMENT

EMBRYOLOGY. *Revised and Enlarged Edition.* *By Lester George Barth. The Dryden Press, New York.* $6.00. xii + 516 pp.; ill. 1953.

The growing interest in developmental biology has created a challenging problem for teachers of embryology. They have encountered an increasing number of students who are interested in the principles of development and who are only secondarily interested in the special embryology of a type form, e.g., the human. This is, indeed, a satisfying trend. Unfortunately, most textbooks of embryology have not dealt with principles or with the experiments designed to elucidate them, but have been chiefly oriented toward the field of developmental anatomy. Thus when the first edition of Barth's *Embryology* was published in 1949, it received initially a warm welcome, for here was a book which illuminated the principles of development from a dynamic point of view (*Q. R. B.*, 26: 80. 1951). Closer inspection and actual use in undergraduate courses revealed, however, that the first edition was a "skeleton" text. The facts of normal development needed to prepare the student to visualize and understand the experiments described were either lacking or so poorly organized and woven into the text as to be of little value. Coverage of organogenesis was superficial, and the schematic drawings lacked realism, and, all too often, accuracy.

Most of these serious criticisms have been overcome in the revised and enlarged edition, which retains the best features of the original text, and has been strengthened considerably by the addition of new material. The descriptions of normal ontogeny of the frog and chick now precede the experimental analysis of development. Coverage of neurogenesis and the mesodermal derivatives is far more complete than formerly. An additional, useful section on comparative embryology of vertebrates has been included. Many of the schematic drawings have been improved, and are supplemented by companion drawings or photographs. Unfortunately, the quality of the photographs shows little improvement. The book is in general free from factual errors.

One serious defect of the first edition has not been corrected. On the whole, the book is stimulating to the undergraduate student; to a considerable degree, the book stimulates interest because Barth has included hypotheses concerning developmental mechanisms. It is particularly unfortunate, therefore, that fact and hypothesis frequently are confused—or at least are not clearly separated. Moreover, too often only one side of a controversial question is included. This defect is most striking in the treatment of the mechanism of differentiation, in which the author adopts, without critical discussion of the several possibilities, a "cytogene" hypothesis of differentiation. No doubt many embryologists will agree with Barth that such a view does represent the best working hypothesis at present, but few will agree with his unequivocal conclusion (following a discussion of the differentiation of amphibian ectoderm) that "the final picture, then, is that during differentiation a stimulus brings about a formation or a release of a cytogene, a cytoplasmic gene, and this self-duplicating unit, by reacting with the nuclear genes, maintains a new type of cell" (p. 407). Such apparently factual, unqualified statements on controversial issues (and there are other examples) have no place in a textbook.

In short, this revised edition is a vast improvement over its predecessor. It has much to commend it. However, it still falls short of the level of critical scholarship that Barth, long a foremost experimenter, has led one to expect of him.

JAMES D. EBERT

FRAZER'S MANUAL OF EMBRYOLOGY. *The Development of the Human Body. Third Edition.* *By J. S. Baxter. Bailliere, Tindall & Cox, London; [The Williams & Wilkins Company, Baltimore].* $8.00. x + 488 pp.; ill. 1953.

This is the third edition of a textbook on human embryology designed primarily for use in medical schools. The first of its two parts (roughly one-fifth of the whole book) deals with the early stages and some of the general aspects of human development. This part has undergone considerable revision in the hands of Baxter and includes discussion of some of the newer information which was not found in the first two editions. The second part is left essentially unchanged. It is unusual only in that its material is organized from the regional rather than the systematic approach, i.e., the developing embryo is described region by region rather than organ system by organ system, as is more frequently done. This organization may seem more logical to those who prefer the regional approach in the study of anatomy.

Paragraphs presented in fine print give very brief comments on the comparative embryology of various structures, describe certain anomalous conditions, or convey information which is apparently considered to be slightly irrelevant to the general context. The book contains neither glossary nor bibliography but some important references are briefly cited by giving the name of the author and the year of publication.

J. N. DENT

GROWTH AND DEVELOPMENT.

By Karl C. Garrison; with chapters respectively by Florene M. Young and Florence Heisler. Longmans, Green & Company, New York, London, and Toronto. $5.00. xii + 559 pp. + 16 pl.; text ill. 1952.

The purpose of this book is to summarize the results of variously oriented scientific studies of human development from prenatal through childhood years, in order to provide a useful background for the guidance of children. According to an introductory statement, "the author has designed his text for the teacher in training, but it will be useful to all concerned with the intelligent guidance of children." This is but the first of many misconceptions promulgated in the book, which is poorly written by an author who seems incompetent in many of the areas discussed. Surely our prospective teachers and parents deserve a more scholarly and thought-provoking treatment of this important field than the author has presented. His treatment of the subject is shallow and frequently tends to obfuscate rather than clarify. The superficiality of coverage is most disturbing in several areas, notably embryology, genetics, and physiology, in which the author obviously goes beyond the limits of his understanding, as evidenced by numerous errors and supposedly factual statements that are either controversial or actually contrary to fact. Among the more glaring examples are the following: "The pituitary gland has sometimes been referred to as the master gland since it (the anterior lobe) produces a growth hormone, and the posterior lobe produces a stimulating hormone for the other glands"; and "The best known of the endocrines is the thyroid gland. . . .Iodine, produced by this gland, is essential. . .etc." Topics which urgently demand clarification and amplification include (to cite a few) the Rh factor, antibody production in the newborn, hyperplastic and hypertrophic growth, and the role of proteins in nutrition.

The questions and exercises at the end of each chapter add little to the text, since they are not designed to elicit thought. On the credit side, the inclusion of both author and subject indexes should be noted. In summary, the author has done himself a disservice in presenting to the public a book so carelessly written. It is not recommended for either a professional or lay audience.

JAMES D. EBERT

PIGMENT CELL GROWTH. *Proceedings of the Third Conference on the Biology of Normal and Atypical Pigment Cell Growth.*

Edited by Myron Gordon. Academic Press, New York. $7.00. xiv + 365 pp. + 15 pl.; text ill. 1953.

This book is made up primarily of a collection of 22 papers presented at the Third Conference on the Biology of Normal and Atypical Pigment Cell Growth held in November, 1951, under the sponsorship of the New York Zoological Society. It includes also a preface by the editor and organizing chairman, Myron Gordon, the reported discussions following each paper, and an index prepared by James Atz. The outlook of the group which has organized this series of conferences is broad, and it attempts to exclude no aspect of work involving pigment cells. Consequently, the papers appearing here are in a sense quite heterogeneous, since they were presented by embryologists, physiologists, biochemists, geneticists, endocrinologists, and clinicians. Yet, as one reads these assorted papers, it becomes increasingly apparent that each of the specialized disciplines represented has a contribution to make toward the general understanding of the pigment cell.

Such aspects of the biology of the pigment cell as the following are considered: (1) the origin and migration of typical mammalian pigment cells; (2) the role of endocrine factors in melanophore development and behavior in amphibians, fish, and fowls; (3) the genetical control of pigmentation in the fowl; (4) the growth, pathology, and distribution of melanomas in fish, mice, and human beings; (5) the chemical structure of melanins; and (6) the enzymology of melanin formation. Occasional mention is made of pigments other than the melanins, but nonmelanic pigmentation was largely ignored by this Third Conference.

New information of a specialized nature will be found in the individual papers. Also, a fairly comprehensive, generalized concept of the present status of research on melanin-forming and -bearing cells can be synthesized by the person who, with very little background knowledge in the field, attempts to read and comprehend the book as a whole.

J. N. DENT

CONGENITAL DYSPLASIA OF THE HIP JOINT AND SEQUELAE (*In the Newborn and Early Postnatal Life*).

By Vernon L. Hart. Charles C Thomas, Springfield, Ill. $5.50. xvi + 187 pp.; ill. 1952.

In this monograph, the author records his Detroit Orthopaedic Lecture, delivered in 1948. The references in the book indicate that he has brought his subject material up to date. He describes congenital dysplasia of the hip as a pathologic condition characterized by an interruption of the normal growth forces of the tissues that form the skeletal structures of the hip. Under the stresses of abnormal pressure, muscle pull, and weight-bearing this inadequacy may lead to any of a number of clinical syndromes, such as subluxation, coxa magna, osteoarthritis, and congenital dislocation of the hip. The pathogenesis is considered in detail and is followed by a description of the clinical findings and treatment. The text is easy to read, though there is a good deal of repetition. With the generous use of well reproduced and fully annotated illustrations, the author's thesis is presented convincingly. The book is well worth having and reading.

I. Wm. Nachlas

ANIMAL MORPHOLOGY

Submicroscopic Morphology of Protoplasm. *Second English Edition.*

By A. Frey-Wyssling. Elsevier Publishing Company, Amsterdam, Houston, London, and New York. $8.00. viii + 411 pp.; ill. 1953.

This book originally appeared in German as a *Protoplasma* Monograph in 1938, was revised and translated into English in 1948, and now appears in its third edition (the second in English). The last two revisions have had as their chief aims the addition of the growing evidence derived from electron microscopy, though in fundamental point of view there has been no great change since the first edition.

The author, whose earlier contributions were made as A. Frey, is a prominent Swiss botanist and a direct scientific "descendant" of famous German scientists (C. Nägeli, V. von Ebner, H. Ambronn, O. Wiener) whose investigations of optical properties of tissues did much to provide foundations for "submicroscopic morphology." In botanical and optical areas the author writes most authoritatively. The book is intended "not for specialists, but for students." While the references are generally abreast of the latest investigations available at the time of revision (1951 to 1952), the subjects covered are advancing so rapidly that a lengthy manuscript is doomed to become somewhat obsolete faster than it can be written and published. Rapidly developing scientific areas are also likely to involve controversial subjects. Such a book demands of its non-specialist reader that he be alert to other points of view and rely on the shorter annual reviews for more recent developments. Nevertheless, it is difficult to find under one cover in English a better means of introduction to this fascinating area of biological science.

Richard S. Bear

Histopathological Technic, *Including a Discussion of Botanical Microtechnic. Second Edition.*

By Aram A. Krajian and R. B. H. Gradwohl. The C. V. Mosby Company, St. Louis. $6.75. 362 pp. + 7 pls.; text ill. 1952.

This short, practical book deals primarily with methods of fixing, embedding, sectioning, and staining of pathological human specimens. In addition, there is a chapter on botanical microtechnique by E. D. Woodhouse and another on the central nervous system. The book should be useful for class purposes in the teaching of laboratory technicians. Theory and history are so largely neglected as to make the book worthless for college students, of whom one expects something more than cookery.

Isidore Gersh

Elements of Chordate Anatomy.

By Charles K. Weichert. McGraw-Hill Book Company, New York, Toronto, and London. $5.50. vii + 451 pp.; ill. 1953.

This neat, carefully prepared volume is a condensation of the same author's longer *Anatomy of the Chordates*. It is designed for a one-semester course, sketching only the broad outlines of its subject. Three essentially introductory chapters on approach, subdivisions of the phylum and individual development, are followed by 11 chapters on structural and functional systems. The final chapter is a summary of characteristics and advances in chordate anatomy. The illustrations are mostly line drawings, but include some half tones. There is an extensive index but no bibliography. This book is well suited for its special purpose. It may also be recommended, as recreational reading, to those who wish to acquire a satisfying general concept of chordate anatomy without having to struggle with minutiae.

F. N. Low

Manual of Comparative Anatomy. *Second Edition.*

By Osmond P. Breland. McGraw-Hill Book Company, New York, Toronto, and London. $4.50. xi + 256 pp. 1953.

This manual offers detailed laboratory instructions for the study of amphioxus, lamprey, dogfish, perch, necturus, turtle, cat, and pigeon. It should be adequate enough for the mechanical routine of dissection, but

the complete lack of illustrations postulates auxiliary manuals and thus limits its usefulness.

F. N. Low

DENTAL ANATOMY, *Including Anatomy of the Head and Neck. Third Edition.*

By Moses Diamond. The Macmillan Company, New York. $15.00. xiv + 471 pp. + 32 pl.; text ill. 1952.

Due to the interest of his son, who is not a dentist, this third edition of a proven text and reference book has been published posthumously. "Diamond" is a fine book for the dentist and dental student to own and study. A little more than half the pages are devoted to an orderly and clear presentation of the comparative morphology, development, eruption, individual forms, variations, and occlusion of the teeth. Other chapters of this section deal with the tooth tissues and supporting tissues of the teeth. All this is beautifully illustrated, many of the illustrations being photographs. The chapter on Technique for Reproducing Basic Tooth Forms will be of great use to dental students.

The second half of the book is an atlas of the head and neck and an extensive descriptive anatomy of the head and neck. This includes many fine illustrations and a chapter on the growth and development of the skull.

It seems that a considerable service to prospective users would be accomplished by separating these two parts into two volumes and allowing them to be sold separately. The primary interest and usefulness of the book seems to lie in the Dental Anatomy rather than in the Head and Neck portion. This would, of course, necessitate rearranging the extensive index and the bibliography of more than 300 titles. As it stands, the book is a fine monument to an able man.

JOHN A. CAMERON

ANIMAL PHYSIOLOGY

A PHYSIOLOGICAL APPROACH TO THE LOWER ANIMALS.

By J. A. Ramsay. Cambridge University Press, New York. $2.75. ix + 148 pp.; ill. 1952.

The aims of the author in presenting this introductory study are best stated by direct quotation from the jacket. "Dr. Ramsay holds that the student is likely to be misled if he seeks to interpret the physiology of the lower animals in terms of the physiology of the mammal; it is better to start afresh by defining the general problems that face all animals, and then to show how these problems are solved at various levels of structure and organisation." This book is essentially a very concise introduction to comparative physiology directed to senior high school students and college freshmen. Each chapter deals with a basic physiological problem, namely, nutrition, circulation, respiration, excretion, muscle and nerve, sense organs, coordination, and behavior.

The approach attempted here is not new. Sporadic attempts in this direction have been made to a greater or lesser extent from time to time. An early example somewhat along the same lines was C. R. Plunkett's *Outlines of Modern Biology*, published first in 1929. All such attempts have not been notably successful, largely because the time was not ripe. Recent years have witnessed an increased interest in the physiology and biochemistry of invertebrates and a growing awareness of the useful purposes these animals might serve in teaching and research. Heretofore, this awareness seems to have originated with the specialists and only partly to have filtered down to the student and the teacher of introductory courses. Ramsay's book fills a great need and may be the long-awaited means of propagandizing the usefulness of the invertebrate for teaching purposes. The book is well written, stimulating, and provocative. It is as complete as is consistent with its introductory nature and conciseness. As the author himself points out in the Preface, he has laid himself open to a charge of over-simplification and omission; however, the avowed purpose of this little volume and its effect in opening the eyes of a student and stimulating him to further inquiry seem to more than compensate for any failings resulting from broad generalization. This book is recommended most heartily to students and teachers who seek a spur to incentive and a clear, logical, and authoritative approach to certain aspects of the study of Biology.

V. G. DETHIER

INSECT PHYSIOLOGY.

Edited by Kenneth D. Roeder. 15 Other Authors. John Wiley & Sons, New York; Chapman & Hall, London. $15.00. xiv + 1099 pp.; ill. 1953.

Insects are the most numerous and most adaptable group of animals. More than one million different species have so far been described, and this task alone, in conjunction with studies on their morphology, distribution, and habits, has been an unending challenge to an army of professional and amateur entomologists for a century or longer. More recently it has been recognized that the abundance, adaptability, and variability of insects, which have made them such fascinating organisms for study by the naturalist, also make them eminently suitable and interesting for physiological investigations. The very special problems which the physiology of insects poses have heretofore attracted the less orthodox and more imaginative physiologists. It was only during the past 30 years or so that insect physiology has been

gradually converted from the happy hunting ground of a few individuals to a highly integrated branch of biological research. Witness of this startling progress is this new text, edited by K. D. Roeder with the cooperation of 15 experts, and constituting by far the most up-to-date and extensive treatment of the subject. Out of about 3000 titles cited in the bibliography, which comprises no less than 106 pages, more than half are dated later than 1935! Roeder's book is about twice the size of the other existing textbook by V. B. Wigglesworth (2nd edition, 1952) and differs from it by the greater emphasis on the physiological, physico-chemical, and biochemical aspects, while the "Wigglesworth" rather excels in the aspects of functional morphology. Some of the sections constitute the first comprehensive modern treatment of certain aspects of the subject. Special mention should be made here of 3 chapters (80 pages) on flight, by L. R. Chadwick, 4 chapters (124 pages) on behavior, by T. C. Schneirla, and 4 chapters (150 pages) on experimental morphology and the role of hormones, by D. Bodenstein. There are in all 32 chapters, the book being subdivided as is conventional for physiological texts. The general biologist who has been unaware of the striking development in the physiology of insects will discover that insects have, at long last, taken their rightful place beside bacteria, the frog, and the mammals, as subjects for the study of general physiological principles, and that, by virtue of their smaller size, the ease with which they can be handled and propagated, and their particular adaptability to a wide range of environmental conditions and different kinds of food, they often constitute the most promising and fruitful subjects. This would especially seem to apply to research in the smaller laboratories with less extensive equipment, and to teaching in high schools as well as colleges. Their use may also be less offensive to the anti-vivisectionist. In the utilization of insects in studies in the whole range of physiological experimentation, the new *Insect Physiology* will be an invaluable and reliable guide.

G. FRAENKEL

TEXTBOOK OF PHYSIOLOGY. *Eleventh Edition.*

By William D. Zoethout and W. W. Tuttle. The C. V. Mosby Company, St. Louis. $4.75. *692* pp. + 5 pl.; text ill. 1952.

The present edition of this standard textbook should continue to fill the gap between brief surveys of physiology and the more voluminous reference works. Although it leans somewhat to a treatment of personal hygiene, it nevertheless presents the pertinent facts of general physiology. The book also contains a glossary and refers to a selection of general readings.

ECKHARD H. HESS

WATER AND SALT DEPLETION.

By H. L. Marriott. Charles C Thomas, Springfield, Ill. $2.50. x + 80 pp.; ill. 1952.

This monograph in the American Lectures in Physiology series constitutes a revision of two Croonian Lectures delivered in 1946. It is a well-written discussion of current views of the quantitative aspects of the physiology of water and salt depletion, from the viewpoint of a clinician, and includes considerations of differential diagnosis, prevention, and treatment. The point is well made that it has been unfortunate that the historical progress of medical discovery caused attention first to become focused on acid-base disturbances. This accident of history has resulted in undue preoccupation with acid-base changes, in cases of Na and Cl depletion, to the relative exclusion of the more serious effects due to loss of "extracellular osmotic pressure." The author does not consider K depletion, which has recently assumed importance in some types of dehydration.

EVELYN HOWARD

SURGERY AND THE ENDOCRINE SYSTEM. *Physiologic Response to Surgical Trauma—Operative Management of Endocrine Dysfunction.*

By James D. Hardy. W. B. Saunders Company, Philadelphia and London. $5.00. xii + 153 pp.; ill. 1952.

This is a useful review of present-day concepts in endocrinology for the surgeon. Recent advances in endocrinology have a profound influence on surgical reasoning, and these advances are aptly summarized in the present volume. The chapter on Metabolic Aspects of Body Fluid Regulation and of Shock is one of the best of the book and reflects the original work in this field done by the author. The chapter on the thyroid gland does not confine itself to surgical procedures, but the use of radioactive iodine is discussed also. It is a bit surprising that the treatment of adrenal hyperplasia with cortisone is not mentioned in a book which appeared in 1952. This is however a very minor omission in an excellent treatise, which can be warmly recommended to surgeons and physicians. The book is well illustrated and adequately indexed.

WALTER FLEISCHMANN

THE SUPRARENAL CORTEX. *Proceedings of the Fifth Symposium of the Colston Research Society, held in the University of Bristol, April 1st–4th, 1952.*

Edited by J. M. Yoffey. Academic Press, New York; Butterworths Scientific Publications, London. $6.80. viii + 232 pp.; ill. 1952.

Edward Colston, the noted seventeenth-century philanthropist and educationalist, was first honored by

the citizens of Bristol in 1899. Generally philanthropic in its aims and operating through the University of Bristol, the Society now devotes the major part of its funds to an annual Symposium. Topics previously treated have been of general University interest. The present symposium is the first on a biological subject. It consists of 20 authoritative papers followed, either singly or in small groups, by open discussion. There is wide variety of subject material, analyses of the suprarenal cortex ranging from basic science to clinical psychiatric application. As in all symposia, each contribution is the author's account of a special topic, prepared essentially without reference to other papers in the group. But it would be difficult to find in one binding more or better up-to-the-minute information on the suprarenal cortex.

F. N. Low

ANTERIOR PITUITARY SECRETION AND HORMONAL INFLUENCES IN WATER METABOLISM. *Ciba Foundation Colloquia on Endocrinology, Vol. IV.*

G. E. W. Wolstenholme, General Editor for the Ciba Foundation, assisted by Margaret P. Cameron. The Blakiston Company, New York. $7.50. xxii + 591 pp. + 24 pl.; text ill. 1952.

The full title of Book I of this symposium, which appears only on page xviii of the volume, is: Control of the Anterior Pituitary and Reciprocal Relationships between its Secretions and those of Target Organs. There are 37 formal presentations, under the following headings: Anatomy, Histology and Cytology; Control of Secretions of the Anterior Pituitary; Growth Hormone; Gonadotrophins; Thyrotropic Hormone; Adrenocorticotrophic Hormone; and Lactogenic and Mammogenic Hormone. Thus there should be something here for everybody remotely connected with any phase of pituitary physiology, with the possible exception of the pinealists. The presentations, even where nothing of great or original moment is forthcoming, usually subserve their purpose by initiating topical discussions. One cannot escape the impression, however that this material is largely part of the ephemera of science, and that the format is quite unnecessarily formal and costly. On the other hand, the photomicrographic representations are technically worthless. This, then, is a discussion of work done or in progress up to July, 1951—a source of considerable information to a reader not devoid of the patience to ferret it out.

In commenting on Book II of this symposium, one is tempted to jump immediately to the excellent summing up by its Chairman, Solly Zuckerman, and in particular to his remark that "Sooner or later we shall have to sit down to discuss the general homeostatic control of the body, as well as particularizing about separate aspects of a total metabolism." For purely practical or clinical reasons, the complex problem of water balance tends to become split between the renal and the non-renal aspects—the latter being a comfortable, negative expression for everything that happens at the tissue level. This dichotomy showed up rather sharply in the deliberations. As to the treatment of ionic interrelationships at the level of cells and tissues, the discussion tended to be weighted towards concepts involving active (i.e., metabolism-linked) ion extrusion (Conway and Verzar). There are alternative hypotheses in terms of Donnan equilibria, ion exchange, and the like, that were only very casually considered. I found this symposium a worthwhile one, perhaps because the attention of the participants was focussed on a reasonably manageable segment of physiology. One personal observation, directed to the opening remarks of the Chairman concerning edema: it is still likely that a solution of "The Curious Case of the Baboon's Bottom" is basic to our understanding of water and electrolyte balance.

H. N. CATCHPOLE

VERGLEICHENDE PHYSIOLOGIE. *Band II: Nervenphysiologie.*

By W. von Buddenbrock. Verlag Birkhäuser, Basel. Sw. fr. 34.40 (paper); Sw. fr. 38.50 (cloth). 396 pp.; ill. 1953.

The material covered in this volume was originally combined with sensory physiology in the 1937 edition of this work. Much new material has made a separate volume necessary. The organization of the book is along the usual lines. There is first an account of the nervous system of protozoans, and then of the general neurophysiology of metazoans. Then follows a systematic account of the special neurophysiology of phyla, beginning with the coelenterates and ending with the vertebrates. This last part is organized in terms of the major divisions of the brain and spinal cord and considers fishes, amphibians, reptiles, birds, and mammals in turn. The volume contains a thorough bibliography and should be of interest not only to the physiologist but also to the psychologist, since many references to animal behavior, in terms of neural processes, are included.

ECKHARD H. HESS

THE NEURON. *Cold Spring Harbor Symposia on Quantitative Biology. Vol. XVII.*

The Biological Laboratory, Cold Spring Harbor. $8.00. xiv + 323 pp.; ill. 1952.

This symposium on the properties and function of the neuron is related to and in a sense serves as a continuation of the 1936 symposium on *Excitation Phenomena*. Twenty-six papers are included in the volume and the discussions which occurred are appended to each.

A preliminary survey of the anatomy of the neuron and the diversity of cells is given by David Bodian. The significance of the absence of terminal boutons on distal parts of dendrites and their presence on the cell body and proximal portions of the motoneuron dendrites is discussed. Thirty-eight per cent of the surface of the cell body may be involved in synaptic contact. Synaptic junctions on motoneurons differ morphologically. The significance of these differences, the distribution patterns of endings, and possible changes in synaptic density are discussed. J. M. Tobias describes some optically detectable consequences of activity in nerve in the second paper, but these studies have not advanced far enough to make much contribution to the comprehension of the mechanism of neuron function. The hypothesis of saltatory conduction is reviewed and ably supported by B. Frankenhaeuser. Additional information is given in a discussion by H. S. Gasser. The saltatory conduction theory is given further support by I. Tasaki in his paper on the conduction of impulses in the myelinated nerve fiber. The next sections of the volume deal with the properties of nerve axons. A. L. Hodgkin and A. F. Huxley's measurements of nerve potentials, the movements of sodium and potassium, and membrane permeability changes as studied by the "voltage clamp" technique are described. The measurement of oxygen uptake in active axons is discussed by F. Brink and his associates, and biochemical concepts of the processes connecting the conduction of impulses to the rate of oxidation are presented. The damping factor as a functional criterion in nerve physiology is dealt with at length by A. M. Monnier. The nerve is considered to be analogous to many physical systems which can display either a periodic or a non-periodic character according to the magnitude of one of their parameters. Monnier calls the parameter of the nerve the "damping factor." The natural periodicity of a normal quiescent nerve is marked by a high damping factor. In concluding this section P. D. Therman dealt with electrotonic potentials and excitability changes in nerve, while T. Shedlovsky presented a model for bioelectric phenomena in a discussion of electromotive force from proton-transfer reactions. In the third section of the symposium the peripheral origins of nerve activity in muscle stretch receptors (C. C. Hunt), in the visual system (H. K. Hartline and associates), and in the ear (H. Davis, I. Tasaki, and R. Goldstein) are reviewed. Although the remainder of the symposium is divided into sections, the individual papers are not closely integrated, and a different relationship might have been helpful. The very interesting presentations by C. A. G. Wiersma and T. H. Bullock contain much information about invertebrate neurons and synapses. J. C. Eccles' paper deals not only with the properties of the motoneuron as determined by intracellular electrode recording, but also with central synaptic transmission. Transmission in the cord, sympathetic ganglia in the retina, and at the neuromuscular junction is discussed by other physiologists. This volume is a valuable contribution to neurophysiology, but it is highly specialized in parts; and many physiologists may find some sections difficult to comprehend.

CHANDLER MCC. BROOKS

PHYSIOLOGICAL FOUNDATIONS OF NEUROLOGY AND PSYCHIATRY.

By Ernst Gellhorn. The University of Minnesota Press, Minneapolis. $8.50. xiii + 556 pp.; ill. 1953.

In a challenging and unique approach to an almost chaotically diverse subject, Gellhorn has assembled much of the best of recent work on the physiology and pathology of the nervous system and its relations with the internal environment. A great deal of his own work and that of colleagues in his laboratory is presented here for the first time. Much of the book, in fact, is a collation and interpretation of the life-work of the author, aided by the considerable number of investigators who have worked with him. This emphasis on research with which the author is most familiar does not, however, occasion so much neglect of the work of other investigators as might reasonably have been expected.

By his own admission the author makes no attempt to compile an index to all recent neurological research. The goal of the book is interpretative rather than encyclopedic. By no means all of the physiological foundations of neuropsychiatry are covered. Those which have been selected as significant, however, will be found to be of more than passing interest to nearly everyone concerned with the activity of the central nervous system and in the consequences of such activity in normal and pathological behavior.

Six major divisions of the text are to be found: factors regulating neuronal activity; the physiology and pathology of movements; the physiological basis of consciousness; aspects of autonomic physiology; and two final sections on integrations and applications. Through most of the text the importance of the communicating system between cortex and hypothalamus is emphasized. Particular attention is given to the corticopetal division of this system. Although a considerable part of the book is devoted to the activity of individual neurons and to voluntary and involuntary movements, one gets the impression that these discussions are no more than necessary prefaces to a hypothalamic theory of motivation and indirectly of behavior (which presumably is motivated). It is this hypothalamic theory and its ramifications which constitute the major thesis of the work. The functions of the hypothalamus as the principal central representative and regulator of the autonomic nervous system are linked to a diversity of physiological

phenomena that include endocrine function, emotion, autonomic-somatic integration, internal and external homeostasis, perception, the conditioned response, and mental illness. The interpretations and hypotheses advanced are highly suggestive, and will very likely prove productive of much vigorous research designed to refute or support them. In some instances the interpretations are not altogether convincing, and the data cited in support of them are neither decisive nor complete. The author's belief, for example, that insulin coma produces a restoration of conditioned responses via a heightened cortical excitability has been subjected to an alternative interpretation in recent psychological literature in terms of a weakening of recent memory traces, i.e., disinhibition. Such examples are relatively rare, and in general the author shows considerable ability and insight into the problems he has chosen.

A fairly large proportion of the book is concerned with the results of pharmaco-physiological investigations. Since few neurophysiological texts treat extensively this type of research, the book is worth reading for this reason alone, despite the fact that the style is occasionally as involved as the subject matter, and the reading consequently proceeds slowly.

In the concluding chapters, Gellhorn presents a theory of the causes and treatments of mental illness, particularly schizophrenia. The hypothesis is presented that a hypothalamic imbalance is associated with psychological disorders. It is believed that the reactivity of the sympathetic centers is at fault, and the major effects of clinical procedures such as shock therapy are thought to be due to their prolonged excitatory action on central sympathetic structures. The author also believes that the mecholyl test first proposed by Funkenstein, Greenblatt, and Solomon is a useful diagnostic instrument in discriminating between hypo- and hyper-reactive types and in indicating the kind of treatment (shock or sedation) most likely to succeed. Only a great deal of further research can tell whether or not the proposed theory and test are at last a significant step forward in the treatment of mental illness or only another of the many false starts.

The task of integrating the 1263-item bibliography, though sometimes ponderous in style, is nevertheless well done. It is outstandingly apparent that a great deal of scholarship has gone into the task. To me the book is both provocative and informative, and if it is occasionally biased or incomplete it is honestly so. I do not hesitate to recommend it to anyone with a broad interest in the neurological sciences.

O. THOMAS LAW

BIOLOGICAL ACTIONS OF THE ADENINE NUCLEOTIDES. *By H. N. Green and H. B. Stoner; with a foreword by Sir Edward Mellanby. H. K. Lewis & Company, London.* 25s. xvi + 221 pp.; ill. 1950.

The important and fundamental researches of H. N. Green and his coworkers on the effects of adenine nucleotides on certain aspects of circulatory physiology are presented in the present volume in some detail. The possible relation of this work to the etiology of shock is discussed at length, and a number of suggestive experiments are cited. The technical difficulties which have in the past precluded more definitive studies in this field may largely disappear with the recent introduction of assay methods of much greater sensitivity. Doubtless this book will serve to stimulate the application of these techniques to the problems posed here.

The authors are well aware that shock is a very complex phenomenon, and that the adenine nucleotides at best are only part of the story. However, as is well pointed out, the shock-producing effects of adenosine triphosphate and its degradation products are of considerable interest, quite apart from any immediate clinical application. The fundamental problem raised concerns the differential effects inside and outside of living cells of a family of key substances.

NORMAN G. ANDERSON

ANIMAL NUTRITION

FOOD FOR LIFE. *Edited by Ralph W. Gerard. The University of Chicago Press, Chicago.* $4.75. xiv + 306 pp.; ill. 1952.

Food for Life is the combined contribution of Richard J. Block, Norman Jolliffe, Clive M. McCoy, Sedgwick E. Smith, Samuel Soskin, and of Ralph W. Gerard, the editor. The volume presents a brief but comprehensive coverage of our present knowledge of nutrition. Seldom are the fundamental problems of nutrition stated so clearly as in the first chapter of this book. Students, and laymen interested in nutrition, will certainly gain a sense of direction after completing this section. The entire book is written in an informal style, and the authors present the basic concepts of nutrition in an almost entertaining manner.

R. VAN REEN

FOOD AND NUTRITION. *Second Edition. A William Wood Book. By E. W. H. Cruickshank. The Williams & Wilkins Company, Baltimore.* $6.50. xii + 443 pp. + 19 pl.; text ill. 1951.

This volume is the 2nd edition of a textbook first published in 1946. The early chapters of the book are concerned with general discussions of energy, protein,

mineral, and vitamin requirements. Later chapters are devoted to a consideration of the foods which provide the required nutrients. One unique feature of the volume is an interesting Introduction, on the evolution of human dietaries; and this is followed by a timely discussion of the problem of world malnutrition and nutrition in Great Britain.

R. Van Reen

BIOPHYSICS AND GENERAL PHYSIOLOGY

Deformation and Flow in Biological Systems.

Edited by A. Frey-Wyssling. North-Holland Publishing Company, Amsterdam; Interscience Publishers, New York. $11.50. xii + 552 pp.; ill. 1952.

This collection of reviews of various types of rheological phenomena in living systems includes such diverse phenomena as flow, convection, elasticity, plastic deformation, contraction, and even growth. The editor views all biological manifestations as to some extent related to rheology, a generalization of somewhat doubtful value as a guide to study, and he here presents an odd assortment of material, much of it treated on a general and informal level. Seifriz contributes 156 pages of rather chatty and personalized comments on the rheological properties of protoplasm. Although the material presented is thought-provoking, the level of physicochemical treatment is not high, and the presentation would have been improved if it had been subjected to condensation. Pryor presents a well-written review of our impressively sophisticated ignorance of the fundamental mechanism of muscular contraction, avoiding injudicious espousal of any one view, but revealing considerable preoccupation with the rubber-like qualities of contractile materials. Frey-Wyssling's discussion of deformation in plant cell walls concludes the group of three papers in Part A on Rheology in Cells. Part B, Translocations of Solutes in Plants, consists of Movements of Water in Higher Plants (R. D. Preston); Latex Flow (A. Frey-Wyssling); Viscous Flow through Elastic Capillaries (J. J. Hermens). Part C, Translocations of Solutes in Animals and Man, includes a scholarly treatment of the rheology of blood and lymph by L. E. Bayliss, and a discussion of cerebrospinal fluid and intraocular fluid by M. Arusler and A. Huber, who manage to say remarkably little. G. W. Scott Blair discusses briefly the rheology of cervical secretions, and seminal and synovial fluids, and there is a short essay by P. Eggleton on certain diffusion phenomena in biology.

The volume renders a service in calling attention to similar aspects of certain rather diverse problems, and in relating, if only by juxtaposition, fields hitherto rather unevenly developed.

Evelyn Howard

Allgemeine Physiologie.

By Albrecht Bethe. Springer-Verlag, Berlin, Göttingen, and Heidelberg. DM. 29.70. vi + 294 pp.; ill. 1952.

In this rather brief textbook the author gives a survey of general physiology which is scarcely complete according to our standards. He makes up for his incompleteness, however, by covering much material which is not found in the usual physiology texts. It is, in a way, a personalized account of basic physiological facts all the way from a definition of the organism to the problem of automaty and periodicity. While the reader may miss references to such items as visual physiology or to the more standard material on the central nervous system, there is nevertheless a wealth of information. The various chapters and sections are not numbered, but their titles include general biological processes, general characteristics of protoplasm, a brief section on teleology, energy relationships, stimulus effects and automaty, general physiology of movement, and relationships within the organism. On the whole, this is a worthwhile supplement to any standard textbook.

Eckhard H. Hess

General Physiology.

By Bradley T. Scheer. John Wiley & Sons, New York; Chapman & Hall, London. $7.00. 613 pp.; ill. 1953.

This is an important new textbook, which summarizes significant aspects of current developments in a thoroughly satisfactory manner. It was designed, not as an exhaustive treatise, but as a presentation of material for a thorough first course in physiology for prospective specialists, and assumes an "adequate working knowledge" of biology, chemistry, and physics. Would that all premedical students could have such a course!

As a personal synthesis the writing of this volume represents no mean achievement, including as it does a bibliography of over 1400 papers. The facts presented are followed through to reasonable conclusions, rather than being merely listed. The student is introduced to current thought with a minimum of the theory of the past, but with a sure sense of respect for the limitations of current views. Topics were selected on the basis of whether they permit consideration in mechanistic terms applicable to a wide range of living organisms. The five sections of the book include: 130 pages on physicochemical foundations of life, including cell structure; 100 pages on biocatalysis and metabolism; 110 pages on energy transformations in cells and organisms; 90 pages on development, including two excellent but necessarily highly tentative chapters on the control of development and the mechanism of differentiation, subjects in need of more attention by physiologists; and a final section on integrations, including a beauti-

fully lucid 50 pages on excitation, conduction, and nervous integration, and a rather meager 30-page descriptive summary of the elements of humoral integration, a subject which seems as yet only eligible for inclusion in a book of this kind by virtue of its promising future. All in all, the presentation and the choice of material are so good that it makes one wish to be a beginning student of physiology again, so that one could get this kind of a running start on the subject and be able to say "Why yes, obviously," to concepts that have been won with so much of that patient look that watches "the last oozings hours by hours."

EVELYN HOWARD

BIOCHEMISTRY

GENERAL BIOCHEMISTRY.

By William H. Peterson and Frank M. Strong. Prentice-Hall, New York. $6.50. x + 469 pp. + 4 pl.; text ill. 1953.

When a graduate student in biology decides to take a course in biochemistry he is generally offered the choice of a biochemistry course for pre-medical students, or a watered-down version of medical biochemistry for students in home economics or agriculture. Only in rare instances does the student find a course specifically designed to give the information necessary to understand the problems and methods of modern biochemistry. *General Biochemistry*, by Peterson and Strong, appears to be ideal for use in such a fundamental course. The book is brief and concise, yet it takes up in logical fashion the basic properties of living cells—their composition, chemical activities, and functions.

The first part of the book deals with the nature and structure of the carbohydrates, lipids, proteins, nucleic acids, and minerals. There is a good chapter on the vitamins, their occurrence in different cells, and their physiological functions. The hormones are treated in a similar fashion. G. W. E. Plaut has contributed 2 excellent chapters, one on enzymes, the other on digestion. Three chapters take up in considerable detail the metabolic peculiarities of animals, microorganisms, and plants. The chapter on plant metabolism, by R. H. Burris, contains a good summary of the current status of the photosynthesis problem. The book closes with a chapter on biological energetics and an appendix containing tables on the composition and energy value of foods.

At the conclusion of each chapter there is a list of review questions and a number of references and suggested readings. The references do not attempt to document all of the details of the biochemical reactions described in the text, but rather are references to review articles or "classical" papers intended to give the reader an idea of the scope and magnitude of current biochemical research.

G. R. NOGGLE

PHOTOSYNTHESIS AND RELATED PROCESSES. *Volume II, Part I. Spectroscopy and Fluorescence of Photosynthetic Pigments: Kinetics of Photosynthesis.*

By Eugene I. Rabinowitch. Interscience Publishers, New York. $15.00. xii + 605 pp.; ill. 1951.

As originally planned, Volume II of *Photosynthesis and Related Processes* was to have included 2 sections, one on the spectroscopy and fluorescence of photosynthetic pigments and the other on the kinetics of photosynthesis. Recent studies on the photochemistry of pigments and on carbon dioxide fixation with radiocarbon made it necessary to increase the length of the kinetics section, so that it was decided to publish Volume II as 2 half-sections.

The first section of the present volume is concerned with the spectroscopy and fluorescence of photosynthetic pigments, and will be of most interest to those investigators who have occasion to separate, isolate, and measure the various pigments found in plant materials.

The early part of the kinetics section considers the various methods available for making kinetic measurements of photosynthesis. Detailed descriptions are not given, but rather the principles involved in the measurement of light, oxygen evolution, carbon dioxide consumption, carbohydrate production, and energy conversion. A brief mention is made of isotope tracer methods, but the C^{14} work is to be described in full in Volume II, Part 2. There then follows a general chapter on the external and internal factors in photosynthesis and one on concentration factors, or "how the rate of photosynthesis and the yield of chlorophyll fluorescence depend on the concentration of the reactants." The effect of the concentration of a number of inhibitors on the rate of photosynthesis is also discussed. The last third of the book is devoted to a detailed discussion of the light factor in photosynthesis.

Those familiar with the first volume of this work will find the same high standards of scholarship in the present volume. Biologists are greatly indebted to Rabinowitch for undertaking the formidable task of bringing order and understanding to the literature of photosynthesis.

G. R. NOGGLE

THE MAJOR METABOLIC FUELS. *Brookhaven Symposia in Biology, No. 5. September, 1952.*

U. S. Atomic Energy Commission, Brookhaven National Laboratory, Upton. Public sale: Office of Technical Services, Department of Commerce, Washington. $1.25 (paper). viii + 234 pp.; ill. 1952.

A series of 13 papers grouped under the general headings of glucose utilization, hormonal controls, new metabolic pathways, fatty acids, and ketone bodies, with subsequent discussion. The papers are well documented and there is an extensive index. This volume is a com-

mendable example of the current trend in biological and medical symposia, being made up of well prepared papers, which are followed by pertinent open discussion.

F. N. Low

ADVANCES IN PROTEIN CHEMISTRY. *Vol. VII.*

Edited by M. L. Anson, Kenneth Bailey, and John T. Edsall. Academic Press, New York. $8.50. viii + 411 pp.; ill. 1952.

A striking index of the acceleration of developments in the field of protein chemistry is provided by the fact that, by the use of partition chromatography, it has been possible to identify as breakdown products of proteins more peptides within the past decade than had previously been identified by the classical methods of organic chemistry. The present volume begins with an article by F. Sanger describing the use of the new methods in elucidating the arrangement of amino acids in proteins. A great variety of peptides have been found, so that it is not at present possible to formulate any simple principles governing the amino acid sequences. The structure of collagen fibrils is discussed by R. S. Bear, who remarks that the type of organization adopted in collagen fibrils is particularly interesting from the biological point of view. The tendency of individual molecules to arrange themselves with corresponding chemical features matching transverse to their long axis calls to mind such problems as chromosome pairing and duplication. The protofibril is pictured as a single, regularly coiled polypeptide chain. In general, one must go far across or between phyla to discover differences in the larger structural features, while certain finer details are common to all. An impressive survey of work on the proteins of the mammalian epidermis by K. M. Rudall yields the biologically striking information that the protein from the different layers of the epidermis has outstanding differences in many properties, referable in part to the mucosum being rich in free —SH groups, the corneum containing chiefly the —S—S— linkages. Other subjects reviewed are: Muscle Contraction and Fibrous Muscle Proteins (H. H. Weber and H. Portzehl); Infrared Analysis of the Structure of Amino Acids, Polypeptides and Proteins (G. B. B. M. Sutherland); and Ultraviolet Absorption Spectra of Proteins and Amino Acids (G. H. Beaven and E. R. Holiday).

EVELYN HOWARD

METABOLIC INTERRELATIONS *With Special Reference to Calcium. Transactions of the Fourth Conference, January 7–8, 1952, New York.*

Edited by Edward C. Reifenstein; Editorial Assistant, Shirley L. Wells. Josiah Macy, Jr. Foundation, New York. $4.50. 262 pp.; ill. 1952.

A certain style of scientific writing was developed during the latter half of the 19th century, when rigidly factual reports became the almost exclusive medium of scientific exchange. The groundwork of basic biological and medical science has come down to us in this form. Today, on examining original sources, one is obliged to admire their accuracy and solid permanency, but not without some dismay. Facts are piled upon facts with overwhelming finality, and almost never does one encounter expressions of doubt or speculation. However unscientific the latter qualities may be by definition, it remains that doubt and speculation prod curiosity and stimulate new investigative effort.

In recent years scientific presentations have taken on a welcome tone of informality, in which the reporting of cold, hard facts no longer dominates the scene. Increasingly frequent are published accounts of symposia in which discussions of work in progress are favored over formal reports. In the course of such programs it is not unusual for investigators openly to admit mistakes and failures, formulate pertinent unsolved problems, and even suggest promising methods of attack to other investigators. While still respecting past accomplishment, the emphasis of modern scientific reporting has been shifted so as to stimulate future work.

The Transactions of the Josiah Macy, Jr. Foundation are exemplary of the current trend toward freedom of approach. The title of the representative volume under consideration suggests the wide variety of basic science subjects and clinical applications covered. The 21 papers stress the biochemical aspects of bone, but such topics as structural analysis by electron microscopy and radioautography are included. A wealth of material is presented here and merits the attention of all those interested in the field.

F. N. Low

CHEMISTRY OF WOOD.

By Erik Hägglund. Academic Press, New York. $13.50. x + 631 pp.; ill. 1951.

Hägglund's *Chemistry of Wood* is a new revised English edition of his *Holzchemie*, the last edition of which appeared in 1939. For many years *Holzchemie* has been a widely used reference book in the field of wood chemistry. The new English edition, including chapters by Hägglund's coworkers in the Swedish Forest Products Laboratory, should continue to hold this position.

The book has an introductory chapter on The Wood Tissue covering the subject of wood anatomy. The chapter on The Physical Properties of Wood has been limited to a discussion of the specific gravity and the moisture content of wood. Three main subjects, the wood carbohydrates, lignin, and various aspects of pulping and bleaching, constitute over 80 per cent of the book. These subjects are very well handled, re-

flecting the position held by the author and his co-workers in these fields. The minor components of wood, wood saccharification, wood carbonization, and the decomposition of wood are handled in a brief but adequate manner.

The author of a single volume on wood chemistry is faced with the difficult problem of selection of topics. In the case of *The Chemistry of Wood*, the choice was such as to suit the needs of a large number of workers in the field of wood chemistry. The book is especially noteworthy for its careful and conscientious review of the literature.

The translation from the German was well handled by Peter Oesper. The typography and binding are excellent. Diagrams and graphs are generally good, but as in the previous edition, the photomicrographs are poor.

The Chemistry of Wood fills an important place in the growing list of reference books on wood and wood components. Within the scope set for it by the author, it is authoritative and complete.

JEROME F. SAEMAN

NON-AQUEOUS SOLVENTS. *Applications as Media for Chemical Reactions.*

By Ludwig F. Audrieth and Jacob Kleinberg. John Wiley & Sons, New York; Chapman & Hall, London. $6.75. xii + 284 pp.; ill. 1953.

Most biologists, working with an aqueous system, probably feel that they don't understand enough about water as a solvent without having to worry about non-aqueous systems. They are probably correct, but there is a great deal of information in this book by Audrieth and Kleinberg that should come to the attention of physiologists and biochemists. The first chapter, on the Properties of Solvents, and especially the second chapter, on Acids and Bases, could be profitably read by all biologists. The balance of the book is devoted to a survey of the reactions that can be carried out in a number of non-aqueous solvents: liquid ammonia and ammonia derivatives, acetic acid, sulfuric acid, hydrogen fluoride, sulfur dioxide, acid chlorides, and certain halogens and interhalogens. Some of the reactions that occur in these solvents will be of interest to those biologists concerned with analytical methods or preparative procedures.

G. R. NOGGLE

A GUIDE TO FILTER PAPER AND CELLULOSE POWDER CHROMATOGRAPHY.

Compiled by J. N. Balston and B. E. Talbot; edited by Tudor S. G. Jones. H. Reeve Angel & Company, London; W. & R. Balston, Maidstone. 8s (paper). 145 pp. + 5 pl. 1952.

This book is the product of the manufacturers of Whatman filter paper and cellulose powder, materials that are widely used in chromatographic separations. Since most investigators do not bother to test the wide variety of the different commercially available filter papers before attempting a chromatographic separation, there is probably some justification for emphasizing the advantages of one particular make of paper. The authors present a brief description of the various Whatman filter papers that are available and also discuss some of the limitations of the chromatographic technique.

The major portion of the book is devoted to the application of filter paper and cellulose powder chromatography to the separation and identification of a wide variety of organic and inorganic materials. No extensive experimental details are given, and in most instances it will be necessary to refer to the original article. This part of the book contains references through 1950. There is a brief addendum of papers that appeared in 1951. The book is paper-bound and rather flimsy, but it is inexpensive and should be in the hands of all workers who are using or contemplate using paper chromatography as a chemical or biochemical tool.

G. R. NOGGLE

ISOTOPIC TRACERS IN BIOCHEMISTRY AND PHYSIOLOGY.

By Jacob Sacks. McGraw-Hill Book Company, New York, Toronto, and London. $8.50. vii + 383 pp.; ill. 1953.

It is the fashion of the day to use isotopic tracers in biological and physiological research. Unfortunately, a great deal of such research is virtually useless because of poor planning or faulty interpretation. Indeed, when one sees how much truly outstanding biochemical research is being carried out today without the aid of isotope techniques, it is apparent that it is time to take stock of the advantages and disadvantages of the isotopic tracer method. Sacks has done this, and in his book has attempted to survey the existing literature critically and to indicate those areas of research where such methods are applicable. He has done a fine job, and the book should find a wide use among those workers contemplating the use of isotopic tracers as well as among the experienced workers in the field.

After several brief chapters on the basic concepts of nuclear physics and radioactivity, the measurement of radioactivity, the measurement of heavy stable isotopes, and health physics, the author gets to the heart of the problem with a chapter on the scope of the tracer technique. Here is discussed what can be done and what can't be done with tracers. The balance of the book is devoted to chapters on specific problems in biochemistry and physiology. In these chapters the emphasis is on subject matter and the interpretation of data regardless of the tracer used.

Each chapter is fully documented and contains a list

of references. These references, in connection with a remarkably complete author and subject index, enable one easily to find any topic discussed in the book.

G. R. NOGGLE

MICROBIOLOGY

ANNUAL REVIEW OF MICROBIOLOGY. *Volume 7. Editor, Charles E. Clifton, Associate Editors, Sidney Raffel and H. Albert Barker. Annual Reviews, Stanford.* $6.00. x + 505 pp. 1953.

This useful member of the *Annual Reviews* is by now so well established that a restatement of its aims and organizations would be superfluous. It is almost axiomatic that regardless of the competence of the authors, the more circumscribed topics, which allow some scope for critical analysis, will be more coherent than those which must summarize a wider field. Compare for example Schlesinger's Developmental Stages of Viruses with the Genetics of Microorganisms, by Wyss and Haas. Indeed, it may be questioned whether an annotated list of titles, organized by subject, would not be more useful, candid, and economical as a treatment of this kind of problem. It is too much to ask any author for a critical appraisal of upwards of 200 titles appearing within a single year in a broad field. The short-cuts prescribed by economy also contribute to the awkward style of many of these reports. It is disconcerting to have to flip back and forth to each bibliography to find out whether a given numbered work is not already familiar, particularly in fields already known to the reader. I for one would prefer even to sacrifice a proportion of the reviews in favor of full titles in the bibliographies.

The topics include protozoan morphology (E. Fauré-Fremiet), acid-fast organisms (Bloch), nutrition (Cheldelin and King), metabolism (Stadtman and Stadtman), virus chemistry (Pearson), virus and rickettsial toxins (Cox), antibiotics (Heilman), pathogenic fungi (Nickerson), amebiasis (Porter), helminths (Bueding and Most), food poisoning (Dack), mosquito-borne viruses (Eklund), applications of cortical hormones (Kass and Finland), antibody formation (Haurowitz), nitrogen fixation (Wilson and Burris), industrial fermentations (Ledingham), and water and sewage (Heukelekian).

While the pending rise is regrettable, the moderate price for this review must pose an embarrassing exemplar to its competitors.

J. LEDERBERG

THE NATURE OF VIRUS MULTIPLICATION. *Second Symposium of the Society for General Microbiology, held at Oxford University, April, 1952. Published for the Society for General Microbiology. Cambridge University Press, New York.* $6.50. xii + 320 pp. + 21 pl.; text ill. 1953.

The second symposium in this series is a fitting successor to the first (on bacterial surfaces, *Q.R.B.*, 25: 350. 1950), and we may look forward with anticipation to the continuation of the series. The third symposium, on adaptive mechanisms, is in press. Authors were asked to prepare their papers so that galley proofs might be distributed to the society in advance of the meeting. These were later revised, and discussions added for final publication. I cannot assess how this influences the actual hearing, but the published volumes are all one could ask for. Their success may well flow from a *unity* of theme, which has too often been discarded by overenthusiastic organizers of other symposia. The current volume is an indispensable contemporary record of progress in virus research. Its scope is such as to preclude detailed review of individual articles.

About a third of the papers concern bacterial viruses (Luria, Latarjet, and Fildes-Kay-Joklik) and lysogenicity (Boyd, Lwoff), while Felix, with renewed vehemence, attacked the description of bacteriophages as viruses. This essentially semantic controversy need not be revived here. The chief virtue of *naming* phages as viruses is to attract the attention of other biologists to the methodology of phage work. We would all agree with Felix as to excesses of intemperate generalization from too narrow particulars. For the record, some misimpressions conveyed by Felix's tables should be forestalled. He is the first to deny the exaggerated specificity of either "anti-O" or "anti-H" phages for specific named antigens in the *Salmonella* group.

Remaining papers concern general aspects of animal viruses, usually influenza (Gard, Hoyle, Flewett and Sanders) and plant viruses (Markham, Bawden and Pirie), insect viruses (Bergold), fowl tumors (Carr), and metabolic alteration of virus-infected cells (Bauer). In addition, Chantrenne posed the general problem of specific protein synthesis.

Fulton's "venerable hypothesis of virus multiplication" was especially noteworthy for returning to a description of viruses as intracellular parasitic *organisms*. Undue emphasis has been given in the past to speculation of unprecedented mechanisms of virus multiplication, e.g., a splitting into "sub-units" during the eclipse phase, for which there has never been satisfactory evidence even with the phage system on which they were based. The "venerable hypothesis" anticipated the recent publication by Visconti and Delbruck of a treatment of genetic recombination in phage as a sequence of matings among the virus population of an infected bacterium, and the abandonment by Dulbecco and Luria of the "recombination-of-lethals" hypothesis of multiplicity reactivation, the details of which were the most direct foundation for the "sub-unit" theory. But a "venerable approach" has still to cope with the

insistence (especially by Lwoff) that owing to its non-infectivity, the "prophage" of a lysogenic bacterium is not a virus. Lwoff himself points out the existence of such developmental stages in other parasites.

J. LEDERBERG

BIOCHEMICAL STUDIES OF BACTERIAL VIRUSES.

By E. A. Evans, Jr. The University of Chicago Press, Chicago. $2.75. vii + 68 pp.; ill. 1952.

This small, but not inexpensive, monograph represents a series of lectures delivered by the author at Iowa State College in 1951. It consists primarily of an account of the investigations carried out in the author's laboratory and elsewhere on the multiplication of the phage T6 grown on *Escherichia coli*. Most of these experiments have concerned the extent of incorporation into the new virus particles of labelled components of the parental virus, the bacterium, or the medium, and support the now familiar conception that virus growth consists primarily of the utilization of the biochemical machinery of the host for the further synthesis of virus material, primarily from nutrilites in the medium. This book can well serve as a lucid introductory background to the considerable progress that has been made in this field since the original presentation of the lectures.

J. LEDERBERG

MICROBIOLOGY AND HUMAN PROGRESS.

By Madeleine Parker Grant. Rinehart & Company, New York. $6.75. xviii + 718 pp.; ill. 1953.

Written as a college textbook for introductory courses in bacteriology and microbiology, this book covers a prodigious amount of material, some in considerable detail. It is divided into three parts: The Biology of Microorganisms, with chapters on History, Cultivation, Sterilization, Theories of Life, Classification, Bacteria, Exotic Microbic Forms, Growth, Variation and Heredity, etc.; Microbic Friends of Man, with chapters on Microorganisms Essential to the Life of Man, i.e., the Nitrogen Cycle, and Microorganisms Beneficial to the Life of Man, i.e., Dairy Products, Fermented Foods, Yeast, Textiles, and Vitamin Assay; Microbic Foes of Man, divided into 2 sections, one on Biological Aspects of Infectious Disease including chapters on the Meaning of Health, The Infectious Process—Man Defends Himself, and Science Helps Man Defend Himself—and one on Important Infectious Diseases. These infectious diseases are classified according to the portal of entry, and included with them is a discussion of safe milk, drinking water, and sewage disposal.

The style is pleasing and easy to follow, and the material is presented in an interesting manner. The explanations are clear. The text is profusely illustrated with photographs, diagrams, and charts. The facts presented are on the whole accurate, although there are some glaring exceptions. According to the Preface, this book is "particularly for students whose major interests may lie outside the field of science." One therefore wonders why so much detail is given as to the individual characteristics of the different organisms and the intricate details of some of the routine laboratory tests.

The general impression given is that there has been an attempt to cover too much material in one book by one author.

References are given at the end of each chapter; there is an index.

ELIZABETH I. PETRAN

MICROBIOLOGY OF WATER AND SEWAGE.

By P. L. Gainey and Thomas H. Lord. Prentice-Hall, New York. $5.90. xii + 430 pp.; ill. 1952.

This is an elementary textbook, not only for the study of the microbiology of water and sewage, but also for the public health aspects of water supply and sewage disposal. The first 6 chapters, about 80 pages, introduce the reader to general microbiology. They were written for those students who have had no previous courses in microbiology. The next 225 pages are devoted mainly to water—general considerations, plankton, bacteriology, pollution, purification, rural and miscellaneous waters, and water softening. The remainder of the book contains information on sewage disposal and concludes with a chapter on industrial wastes.

The aims and principles of the examination and purification of water and sewage are well brought out. The authors are also to be commended for achieving their aim "to be easily understood"; the style is readable and not too technical.

The sources of information are not cited, because they would "add to the size and cost of the book, with little or no additional value to the students for which the book is designed." At the risk of being unduly pedantic, I believe myself that this rather unique book would be more valuable, and possibly more valued by some students, if it had a few well-selected references with each chapter or an appended bibliography.

The present book contains material previously published as *Microbiology of Water and Sewage for Engineering Students*. The next expansion might logically add a chapter summarizing current accomplishments and problems, in this era of rainmaking, increasing urbanization, and mounting populations requiring water.

HARRIETTE D. VERA

THE BACTERIOSTATIC ACTIVITY OF 3500 ORGANIC COMPOUNDS FOR MYCOBACTERIUM TUBERCULOSIS VAR. HOMINIS.

By Guy P. Youmans, Leonard Doub, and Anne S.

Youmans. Chemical-Biological Coordination Center, National Research Council, Washington. $5.00 (paper). vi + 714 pp.; ill. 1953.

In their search for a suitable chemotherapeutic agent for the treatment of tuberculosis, the authors have, over the past 10 years, tested a large number of organic compounds in vitro for bacteriostatic activity, and in vivo (mice) for suppressive action against tuberculosis infections. The list of these compounds and their respective tuberculostatic activities (and, in the case of those used in vitro, the structural formulae) make up the greater part (Chapters 4 and 5) of the volume.

The first 3 chapters of the work are devoted to the rationale for the in vitro and in vivo screening program, the experimental methods used, and a discussion of selected compounds from the standpoint of the relation of chemical structure to bacteriostatic activity. The latter discussion is particularly valuable to future research in the field, in that it points up the areas in several chemical series of compounds where the synthesis and the testing of new related compounds is most likely to yield fruitful results.

Although the test data herein presented are essentially negative (as measured against the arbitrary criteria for the experiment) from the standpoint of the discovery of a suitable chemotherapeutic agent for the treatment of tuberculosis, the work will prove extremely valuable, if for no other reason, by preventing the unnecessary duplication of effort on the part of other investigators working in the same field. Chemical formula and alphabetic indices of all the compounds tested are appended.

B. Aubrey Schneider

PARASITOLOGY

The Epibionts and Parasites of the Planktonic Copepoda of the Arabian Sea. *The John Murray Expedition 1933–34, Scientific Reports, Vol. IX, No. 4. By R. B. Seymour Sewell. British Museum (Natural History), London.* £1 5s. (paper). Pp. 255–394; ill. 1951.

HEALTH AND DISEASE

Natural History of Infectious Disease. *Second Edition. By Sir MacFarlane Burnet. Cambridge University Press, New York.* $4.50. x + 356 pp. + 1 pl. 1953.

The first edition of this scholarly work was prepared prior to the advent of antibiotics. Hence a revision which includes something of the nature and importance of recent discoveries in the field is very timely. The fundamental principles of infectious disease have not changed in the recent past, and except for the addition of materials relative to the character and activity of the antibiotic drugs, the content of the book has not been changed.

The subject is presented under 5 broad headings, as follows: Biological Considerations, consisting of 2 chapters that deal with the host-parasite relationship and the evolution of infectious diseases; The Aggressors, 3 chapters devoted respectively to bacteria, protozoa, and viruses; The Processes of Defense, a series of 5 chapters delineating the principles of immunity; The Natural History of Infectious Disease, comprising 8 chapters concerned with the cause and control of infectious and epidemic diseases; and Some Important Infectious Diseases, the last 8 chapters, each of which presents a detailed account of one of the more significant infectious diseases. The work is well illustrated and indexed.

B. Aubrey Schneider

Progress in Fundamental Medicine. *Edited by J. F. A. McManus. Lea & Febiger, Philadelphia.* $9.00. 316 pp. + 2 pl.; text ill. 1952.

Keeping abreast of the latest developments in even a limited area of the field of medicine is a monumental chore for the busy physician. The ever increasing volume of medical and scientific literature makes it literally impossible for him to do his own "sifting" and abstracting, and even the abstract journals do not present a synthesis of the pertinent findings as they relate to each disease entity. Hence there is a growing need for the type of "authoritative discussions" presented in this volume.

The 9 topics covered and their respective authors are as follows: Recent Advances in Parenteral Nutrition with Particular Reference to Protein Hydrolysates (Paul R. Cannon); Melanotic Tumors of the Skin (J. A. Cunningham); Pathology of Systemic Lupus Erythematosus (Paul Klemperer); The Diagnosis of Fungus Infections with Particular Reference to Staining Methods (Albert M. Kligman); The Liver (G. K. and T. B. Mallory); A Survey of Techniques for the Histochemical Approach to Pathology (J. F. A. McManus); Coronary Artery Disease (J. C. Paterson); The Problem of Carcinoma in Situ with Reference to the Human Cervix Uteri (Leland D. Stoddard), and The Recognition of Carcinoma in Situ of the Cervix Uteri by Papanicolaou's Method (W. Kenneth Cuyler); and Non-Silica Pneumonoconioses (J. P. Wyatt).

The selection of 9 such relatively unrelated topics for inclusion in one volume was not fortuitous, but was based on the fact that recent advances in both fundamental and clinical research in these areas have brought new concepts relating to the management of the pathological conditions involved in each. The authoritativeness of the discussions is derived from the fact that

each of the contributing authors has had an important role in delineating the problem and advancing the knowledge in his respective field of endeavor.

In addition to a presentation of his own contributions to the topic, each of the 11 authors has summarized the relevant literature on the subject at hand. The reference lists for the various topics are quite extensive; in combination they represent nearly 900 titles. Sufficient illustrative and tabular materials are presented to clarify the discussions. A brief index is appended.

B. AUBREY SCHNEIDER

SYNOPSIS OF PATHOLOGY. *Third Edition.*

By W. A. D. Anderson. The C. V. Mosby Company, St. Louis. $8.00. 788 pp. + 13 pl.; text ill. 1952.

The third edition of this book is essentially similar to the earlier editions. Revisions in text and advances in pathology have been added. It is a good commuter's volume, easily held while dangling from a strap in a bus or a streetcar. It obviously cannot present the details of pathology and should not be considered a substitute for a standard textbook. Nevertheless, it does review the subject remarkably well. Some of the illustrations are poor, and it is to be hoped that they will be deleted or replaced in future editions. The book can be recommended as an auxiliary volume to medical students and to physicians or biologists who desire a review of human pathology.

RALPH M. KNISELEY

PATHOLOGY IN SURGERY.

By Edwin F. Hirsch; photography by Ines M. Porter. The Williams & Wilkins Company, Baltimore. $10.00. xvii + 474 pp., ill. 1953.

The urge to write a book stirs in many of us, and many surrender, particularly when they have gathered a large and comprehensive experience, well documented by photographs. This book records the experience of a capable surgical pathologist. It is said to be directed to pathologists, surgeons, and surgical residents, and to medical students with some training in general pathology. As a pathologist I found it interesting to sit and share in a colleague's experience and to compare it with my own. However, as a reference book it will have little value to a practicing pathologist. Since it is by necessity one modest-sized volume, it will be more useful as a review for surgical residents or graduate students who are preparing for examinations. It does organize and amply illustrate the lesions seen in general surgical pathology.

Some of the defects of the book might be pointed out. Though in general, the photographs of specimens and microscopic sections are superior and demonstrate the text quite adequately, other illustrations are not of good quality. These add nothing to the descriptive captions and will not give the reader any valid reference points to help him when confronted with a histological section or a gross specimen, either in practice or before his examiner in a practical examination. This same temptation to write a book seems to be extended to including illustrations that do not illustrate. In addition, the photographer has not always insisted on a properly prepared specimen.

If I quarrel with some of the author's terminology, I may only be documenting his claim that there is no agreement in the terminology used in tissue diagnoses. Nevertheless, there are wide areas of agreement in terminology which the author fails to employ. For example, most writings in pathology refer to squamous cell carcinoma rather than pavement cell carcinoma. Hodgkin's disease is not mentioned in the index nor treated as a separate section in the chapter on lymph nodes. It is only briefly referred to as "lymphogranulomatosis" under the heading of reticulum cell sarcoma. Another example, which I cannot ignore, occurs in Fig. 354 A, which is said to be a gland or duct inclusion in a lymph node from the neck. To me, this is a rather typical papillary cystadenoma lymphomatosum (Warthin's tumor). The references listed at the end of each section are limited in number. It would be a good thing if the references directed the reader to comprehensive, easily accessible up-to-date textbooks or original articles in journals. Only the exceptional student or surgical resident will have access to or the ability to translate the frequently mentioned encyclopedic work of Henke and Lubarsch. The logic or criteria used in compilation of the bibliography escapes me.

RALPH M. KNISELEY

HANDBOOK OF ORTHOPAEDIC SURGERY. *Fourth Edition.*

By Alfred Rives Shands, Jr. and Richard Beverly Raney; illustrated by Jack Bonacker Wilson and others. The C. V. Mosby Company, St. Louis. $8.00. 644 pp.; ill. 1952.

The acceptance of this *Handbook* in its earlier editions attests to its usefulness. The 4th edition should prove at least as popular, since it retains the desirable features of the earlier volumes and adds a number of improvements. About 70 pages have been added to the book without reducing its handbook characteristics. The text has been brought up to date. In addition, there have been included several sections on subjects such as Gout, Fibrous Dysplasia, and Brucellosis. The most obvious improvement is in the illustrations, which are more numerous and of better quality. The volume constitutes a valuable guide book for students and general practitioners.

I. WM. NACHLAS

ATOMIC MEDICINE. *Second Edition.*

Edited by Charles F. Behrens. The Williams & Wilkins Company, Baltimore. $11.00. xiv + 632 pp.; ill. 1953.

There is no doubt that the physicians of the future will need to have a general understanding of what is here defined as "Atomic Medicine." There is a rapidly expanding use of radioisotopes in the diagnosis and treatment of certain diseases, and in the study of basic problems in physiology and pathology. In addition we must face the possible use of atomic weapons and the potential use of atomic energy for peaceful applications. This book is meant to present general information about nuclear physics, as well as an outline of the medical uses of isotopes, the biology of ionizing radiation, health protection measures, and allied subjects. It is a volume that should be useful in providing an orientation in the field of both the medical and military aspects of ionizing radiation.

One of my colleagues who is more sophisticated than I in matters of nuclear physics has complained that the physics in this volume is naive. If so, it is all to the good, because the volume is directed to a group of people who are naive indeed in atomic physics. My criticism would be of a different sort. To begin with, I was happy to find that the first chapter did not set the tenor for the writing of those that followed, for on the first page there are two sentences with 58 and 51 words, respectively, and both are difficult to navigate. The writing in this chapter contains phrases seldom used outside of the pulpit or the tabloid newspaper, and certainly out of place in plain scientific writing. Here are examples: "drawn inextricably into the turbulent vortex of events"; "permeates all the sancta of the mighty as well as the ecclesiastic cloisters"; "with all the insouciance of a garage man"; "many of the roseate pictures"; "veritable cascades of weird. . .".

Here and there throughout the book are statements of fact that might be challenged. Concerning the origin of atomic medicine we find an example: "It may be said to have its inception as a new type of medical philosophy sometime between the first click of the counters in the stadium at Chicago, when the first nuclear pile was activated, and the magnificent experiment in the desert of Alamagordo." This is not true. The use of artificial radioisotopes in medicine began in the late nineteen-thirties and early forties, when many fundamental papers on radioiodine and radiophosphorus appeared. Another example appears on p. 314: "It is well known that in Japan there were no permanent definite after-effects of radiation in those who survived, except for cataract formation in a few instances." Perhaps the authors do not regard leukemia as a permanent after-effect. A significant increase in the incidence of this disease has been well documented in the survivors within 2,000 meters at both Hiroshima and Nagasaki.

Certain important omissions are found. Nowhere did I see any reference to the detailed clinico-pathologic study, by Hempelmann and coworkers, of the patients involved in the two nuclear accidents at the Los Alamos Scientific Laboratory. Moreover, the sections on the medical uses of radioisotopes are sometimes sketchy, and are, or soon will be, obsolete in some instances. For example, yttrium and chromic phosphate for use as radioactive colloids are not mentioned, nor is the mechanical scintillation scanning instrument, the "scintiscanner."

These remarks are not meant as condemnation of the book. A radical revision and rewriting, however, could greatly improve it, and make it even more acceptable. The subject matter gathered here cannot be found in any other single volume, and as such is quite useful.

RALPH M. KNISELEY

SECOND ANNUAL REPORT ON STRESS.

By Hans Selye and Alexander Horava. Acta, Montreal. $10.00. viii + 526 pp.; ill. 1952.

This book is the second of a series of annual supplements to *Stress: the Physiology and Pathology of Exposure to Stress*, by Hans Selye. There is first a discussion of the stress concept as of 1952, which concludes with an answer to each of 14 criticisms which have been raised by other authors. Part I lists extensive references of the general physiology and pathology of stress, while Part II deals with its special aspects. More than 4000 references are listed in the final part of this book, all of them made quickly available by a system of cross-references. Part III, entitled Afterthoughts, presents a brief sketch for a unified theory of medicine.

ECKHARD H. HESS

HORMONES, PSYCHOLOGY AND BEHAVIOUR AND STEROID HORMONE ADMINISTRATION. *Ciba Foundation Colloquia on Endocrinology. Volume III.*

Edited by G. E. W. Wolstenholme, assisted by Margaret P. Cameron. The Blakiston Company, Philadelphia and New York. $6.75. xvi + 380 pp. + 9 pl.; text ill. 1952.

Book I. Hormones, Psychology and Behaviour

The field of discussion of this symposium, as its chairman (Solly Zuckerman) remarks, is an extraordinarily wide one: the influence of the steroid hormones on psychological and behavioral reactions. In part, the task of the reviewer has been lightened by the very able summing up which devolved upon the chairman of the conference. Here it is emphasized that this has been an attempt to clarify ideas in what is an essentially documentary phase of a science. That the endocrines affect the nervous system is certain. How they

do so is a mystery. A common feature of all innate patterns of behavior is apparently a temporal and spatial organization of separate components (units?). These patterns are activated or powered by hormones. As to the level of this activation, "many hormones may prime the whole organism so that a spatio-temporal pattern of neuromuscular responses can be triggered by some adequate stimulus." The chairman decries appeals to "constitutional factors" which are outside the realm of experimental control and analysis. The section Debate on Methodology contains valuable observations on clinical research. As to the symposium as a whole, it consists of a large number of quite short, formal presentations followed by open discussion. One feels that a better unity might have been achieved by fewer, more forceful, more authoritative, and more historical presentations. Possibly the field needed to be radically narrowed. But this is a reader's impression, and from the standpoint of the participants the conference seems to have been a lively one and the proceedings should be interesting and informative to workers in diverse disciplines.

Book II. Steroid Hormone Administration

Every day many thousands of tons of creams (some of them containing hormones) are massaged into the human skin in the well-advertised conviction that startling changes will be wrought following their absorption. More seriously, life-saving substances must be administered so as to gain the most effective and long-lasting response. Thus the rather "practical" title of this symposium tends to conceal a topic of considerable human interest. The natural steroids are on the whole quite insoluble substances, which nevertheless also tend to show their effects in remarkably low concentrations. They lend themselves well to administration in every conceivable physical form—solutions, suspensions, emulsions, microcrystals, compressed tablets, fused tablets, vanishing creams; and are susceptible of chemical modification to give wide ranges of solubility and potency. The relevant laboratory and clinical literature is scattered, and the reader will be grateful for having some of this material brought together. Here again fewer and more authoritative presentations might have been offered for general discussion. However, those given are topical, and in one case, that of Parkes on fowl plumage tests, highly pleasing esthetically.

Volume III of the Ciba Foundation Colloquia (Vol. IV also) strikes one as a bicephalic monster conceived for the express purpose of annoying librarians everywhere.

H. N. CATCHPOLE

ENDOCRINE TREATMENT *In General Practice.*

Edited by Max A. and Joseph W. Goldzieher. Springer Publishing Company, New York. $8.00. xiv + 474 pp.; ill. 1953.

This book was written by 21 clinicians to meet directly the needs of the general practitioner for specific clinical guidance. It is difficult to assess the value of this book for the practitioner because of the inclusion of much material which is of interest to the specialist only. The editors have felt it unnecessary to encumber the book with references or discussions of controversial opinions. I cannot share their viewpoint. Anybody who gets interested in a subject will wish to learn more about it or to hear more opinions than one. The chapter on calcium metabolism, for instance, touches on so many questions of this difficult and controversial field that the reader is bound to look for further information. Most readers would appreciate a few key references, for instance, to the work of Albright and Reifenstein. On p. 200 the editors make the statement, that "from the viewpoint of therapy the hypogonadal woman is not a rewarding problem." Many endocrinologists, including myself, are likely to disagree with this statement. Hormonal treatment of hypogonadism in the female can be beneficial not only somatically, but also psychologically. Due to the lack of references the reader is unable to form a clinical opinion of his own. Despite these shortcomings, the book contains a wealth of valuable information on endocrine therapy both in children and adults.

WALTER FLEISCHMANN

ATLAS OF MEDICAL MYCOLOGY.

By Emma Sadler Moss and Albert Louis McQuown. Williams & Wilkins Company, Baltimore. $8.00. ix + 245 pp.; ill. 1953.

Atlas of Medical Mycology is offered as an attempt to simplify the diagnoses of mycoses and the identification of fungi which cause disease in man. It has a pleasing format and is printed on good quality paper. As the title indicates, a pictorial presentation of material is emphasized, and more than half the pages are used for half-tone illustrations of clinical material, cultures, and the microscopic morphology of fungi. The accompanying text is quite brief. There is a pronouncing glossary. Users of the book will find the illustrations helpful and, for the most part, of good quality.

The book contains several errors, either typographical, factual, or grammatical. There are some 20 such errors on p. 7 alone, but fortunately this is not representative. Throughout the book the authors incorrectly use the abbreviation *sp.* for the plural of species (spp.). The mycologist is frequently irritated by such sentences as, "An example of this form is the Trichophyton sp.". The statements that in blastomycosis "the systemic infection is usually primary," that "age sex and race are not contributing factors" in chromoblastomycosis, that "fortunately, a relatively small number

of infected individuals develop coccidioidal granulomas to which they ultimately succumb" (Preface), and others should be rephrased. No reason is given for coining the name *Penicilli* to replace the familiar *Penicillia*.

The authorships of *Actinomyces israeli* and of *Nocardia asteroides* are incorrectly given. On p. 4 *Trichophyton schoenleini* is excluded, by a typographical error, from the faviform group of species. In the brief chapter on Occasionally Pathogenic Fungi the most important pathogenic species of *Mucor* and of *Aspergillus* are not mentioned and "*Penicillium notatum* is represented as the type species." So far as an uninformed reader would be able to tell, *P. notatum* is presented as a pathogenic species. The technical term, "type species," is misused in other connections. *Monosporium apiospermum* is listed and illustrated as a common contaminant, although it is correctly mentioned elsewhere as a cause of mycetoma. The hyphal tips at the periphery of the *Monosporium* granule are incorrectly called "spores." Nor, so far as I know, has *Blastomyces dermatitidis* ever been isolated from saprophytic sources.

It is incorrectly stated that one of the diagnostic features of *Candida albicans* is production of a bubbly froth on the surface of glucose broth. Sabouraud's glucose agar should be made with 2% (instead of 4%) glucose and 1.5% or 2% agar (instead of 3.5%), and the quality of the medium will be improved if a suitable peptone is used. Considerable space is devoted to descriptions and illustrations of the growth of fungi on Littman's oxgall agar. It is stated that "on this medium relatively few colonies of contaminants develop and these remain isolated" (i.e., not spreading), yet in 8 of the 23 paired photographs of 7-day-old cultures of common contaminants the diameter of the colony is clearly greater on Littman's medium than on Sabouraud's.

C. W. EMMONS

A SURVEY OF THE LITERATURE OF DENTAL CARIES. *Publication 225. Prepared for the Food and Nutrition Board, National Research Council under the supervision of the Committee on Dental Health, P. C. Jeans, Chairman, C. A. Elvehjem and C. G. King.*

By Gullorm Toverud, Gerald J. Cox, Sidney B. Finn, Charles F. Bodecker, and James H. Shaw. National Academy of Sciences—National Research Council, Washington. $3.00. x + 568 pp.; ill. 1952.

Under 7 major headings, this monumental contribution to dental progress presents the background of our knowledge of caries. Each section condenses and relates its portion of the literature, and a 58-page bibliography completes the volume. The section headings (Introductory Review; Experimental Dental Caries in Animals; Prevalence of Caries; and Nutrition and Caries) indicate the breadth and scope of the work. Certainly the agencies responsible for this book deserve the gratitude of all of us.

JOHN A. CAMERON

HEALTH INSTRUCTION YEARBOOK 1952.

Compiled by Oliver E. Byrd; Foreword by Lloyd Gage Wetherill. Stanford University Press, Stanford; Geoffrey Cumberlege, Oxford University Press, London. $3.50. ix + 232 pp. 1952.

This convenient source of information for those engaged in public health work contains 273 reports, on various phases of public health activity, set forth in 21 chapters. A summary and comment by the compiler are followed by individual digests in each chapter. The subjects include nutrition, heredity and eugenics, fatigue and exercise, mental health and disease, safety, infection and immunity, occupational health, international health, health services and facilities, and trends and possibilities. There are a bibliography, a list of sources, and author and subject indices.

HARRIETTE D. VERA

YOUR COMMUNITY'S HEALTH. *A Revision of Community Hygiene.*

By Dean Franklin Smiley and Adrian Gordon Gould. The Macmillan Company, New York. $5.50. 454 pp. + 1 pl. + 2 folded charts; text ill. 1952.

This slender volume contains a wealth of factual information ably and enthusiastically presented. The writing is clear and precise, without being unduly technical. It is well indexed and illustrated.

The scope of the subject is broadly conceived. After a brief historical introduction, the four following sections deal with control of the environment, community attack on certain major disease problems, organized protection of specific population groups, and the resources for providing preventive and corrective action. Included are discussions of mental hygiene, sex hygiene, housing, the drug industry, care of the chronically ill, the economics of provision for medical care, and other topics of similar current importance. The final chapter is appropriately entitled, A Look Ahead.

This book is recommended for the broad scope of its factual content, for its practicality, and for the excellence of presentation. It is well designed for profitable reading by the average person. Teachers and professional health workers should find it worth careful study.

HARRIETTE D. VERA

SCHOOL HEALTH AND HEALTH EDUCATION *with Special Consideration of the Teacher's Part in the School Health Program. Second Edition.*

By C. E. Turner with the editorial assistance of C. Morley Sellery. The C. V. Mosby Company, St. Louis. $3.50. 472 pp.; ill. 1952.

This is a new revision of a book published in 1947. A useful and reasonable textbook for teachers in training or in service, it is concerned with organization of the school health program, the contributions and responsibilities of the personnel, and promotion of various phases of activities affecting health. Objectives and principles are reviewed, and protective activities, habit training, and direct educational instruction are considered. Methods for evaluation and sources of material are included. Each chapter has a list of questions and suggested activities for the student. There are a bibliography and an index.

HARRIETTE D. VERA

PSYCHOLOGY AND ANIMAL BEHAVIOR

THE SEX LIFE OF WILD ANIMALS. *A North American Study.*

By Eugene Burns. Rinehart & Company, New York and Toronto. $3.00. xiii + 290 pp. 1953.

This comparative study of the sex life of wild mammals in North America brings together for the first time information on the mating habits of a great variety of kinds—from the tiny shrew to the ponderous whale. Its author brings to the subject freshness from his long experience as timber cruiser, park ranger, and veteran angler—activities which furnished frequent opportunity to observe mammals undisturbed. Yet the approach is scholarly, well indexed though without documentation or illustration. Example follows example in logical fashion as the discussion leads from anatomical features into social organization, the antics of mate seeking, gestation, birth and nursing, training toward replacement, and the inevitable trend toward overpopulation.

LORUS J. & MARGERY J. MILNE

HUMAN RELATIONS IN MODERN INDUSTRY.

By R. F. Tredgold. International Universities Press, New York. $2.50. 192 pp. 1950.

This small volume is written by a British psychiatrist, apparently as a means of introducing personnel workers to the basic concepts and principles of social and clinical psychology as applied to industry. The book, however, seems to stem from the psychiatric couch rather than from the psychiatric practitioner, since it is presented through a sort of free association technique. No plan of presentation is evident in the arrangement of chapters or in the organization within chapters. Each topic treated is picked up seemingly at random and meanders uncertainly to a vaguely defined termination. The explanation for this product is provided in the Introduction, which says that the chapters are class lectures "designed to stimulate group discussion and not intended by any means to be regarded as authoritative pronouncements—for indeed we had no authority to pronounce."

The lectures were delivered in 1947 and 1948 at Roffey Park, an English training center for industrial personnel. Some description of this Center is given in the Chapter 14. The course, consisting of one or two weeks of full-time study, operated chiefly through group discussion and problem solution, employing some lectures together with the non-directive discussion methods developed in the United States at such centers as the Harvard Business School and the National Training Laboratory in Group Development at Bethel, Maine. The aim of the course was the development of skill in handling human relations problems. The chapter content seems directed toward an audience almost totally unversed in psychology.

The sort of material covered is indicated in the chapter headings, which include: Why People Work, Fulfillment at Work, The Essentials of Leadership, The Teaching of Leadership, The Significance of Neurosis in Production, Early Signs of Mental Disorder, and Mental First Aid. Surprising in this list is the number of chapters on clinical problems which are ordinarily reserved for advanced courses in psychology. As might be expected, the treatment of the complex clinical concepts is superficial rather than genuinely simple. Hysteria, for example, is defined as "the unconscious production of symptoms without any adequate organic basis." The author feels that personnel workers should be prepared to spot incipient pathological behavior and administer "mental first aid," just as volunteer disaster workers can be trained to administer physical first aid. Even if we grant that good physical first aid can be administered after the predisaster training usually given, there is certainly no evidence that personnel workers can successfully recognize and alleviate mental symptoms after two weeks' sketchy training. One wonders, therefore, how much harm Tredgold's lectures at Roffey Park have done to date.

The style of the book is perhaps best conveyed by a quotation, since the type of treatment used is uniform throughout. The following paragraph is the entire discussion given under the topic, The Desire for the Approval of the Group, on p. 49:

> This again is obviously concerned with its predecessor [desire to conform to type], but reflection shows that it is perhaps more than an extension of it. It is also concerned with our sense of personal responsibility to the group; but it is not always the case that those strong in the latter also need much of the former, or vice versa. Some people are no doubt, for personal

easons, preoccupied in the quest for approval, but besides this most of us work all the better if we are appreciated and our work approved. The moral of this is not difficult to see, but is apparently hard to act on.

In conclusion, one might hazard the guess that this book is a transcription of informal lectures which were delivered with little preparation and no intention of preservation. For the purpose of starting discussion they may have been useful. But the impulse to publish these transcriptions, just because they were on hand, should have been firmly resisted.

JOAN CRISWELL

HUMAN BIOLOGY

PROCEEDINGS OF THE PAN-AFRICAN CONGRESS ON PREHISTORY, *1947*.

Edited by L. S. B. Leakey, assisted by Sonia Cole. Philosophical Library, New York. $8.75. viii + 239 pp. + 9 pl. + 1 folded map; text ill. 1952.

The *Proceedings* are divided into three sections: Section I covers Geology, General Paleontology, and Climatology, with special reference to African prehistory. Section II deals with Human Paleontology. Section III covers Prehistorical Archeology. The Congress was held in January, 1947, and publication difficulties held up the Proceedings until 1952. Fifty-three papers are reported here. Over half are in Section III.

It is impossible to review 53 papers individually. It is a valuable collection for several reasons. It deals with Africa, an area little known to most workers, but of great value for comparative purposes. It contains a veritable Noah's Ark of subject matter, and the specialist referring to it is liable to find his horizons being broadened through stumbling into unfamiliar fields. Many of the papers contain attempted integrations of geology, pedology, climatology, paleontology, and archeology that are quite stimulating. Few areas of the world have as great a wealth of archeological material spread through as great a range of time as does Africa. Few areas, then, offer as rich a field for such integrative studies. It is noticeable that there are considerable areas of disagreement and considerable variation in interpretation of seemingly comparable phenomena. This is not unexpected in so large an area, within which work has hardly begun.

Major topics covered by these articles are: Pleistocene mammalian studies, Pleistocene climates and problems of climatic change, marine terraces and the problem of eustatic sea levels, lake terraces, soils and especially paleosols as recorders of climatic change, archeological sequences, and new sites from various parts of Africa. As a final note on the unexpected to be found in such collections as this is a section on cave paintings, including a paper on The Influence of Classical Civilizations on the Cave Paintings of South Africa. These feature Mediterranean-appearing people, who of course always said they had sailed around Africa!

GEORGE F. CARTER

CLIMATE, VEGETATION & MAN.

By Leonard Hadlow. Philosophical Library, New York. $4.75. 288 pp.; ill. 1953.

A senior high school or junior college text in elementary climatology, this little book has certain features which may make it attractive—a profusion of illustrations, provocative exercises, clear text. Unfortunately it also has certain serious defects which would make one hesitate to recommend it for a public not in a position to discriminate between the good and the bad. In the matter of presentation, the diagrams are frequently much more complex and difficult to follow than the text, which is lucid and straightforward. Without the benefit of personal instruction by the author, the beginner would have difficulty in following certain of the diagrammatic "explanations." The descriptions of atmospheric circulation adhere closely to classical form, despite the fact that there is today considerable dissatisfaction with that form. To be sure, the novice should not be confused with contradictory detail, but the novice of today is the architect of tomorrow, and he should at least be warned that what he is taught are but simplified, and in some respects inadequate, explanations of a complex and ill-understood set of interactions. However, the greatest failure to prepare the pupil for the problems of tomorrow lies in the author's bland and uncritical adoption of environmentalism in its most naive and uncritical form. "In tropical lowlands white men find life almost unbearable"; "troops have sometimes preferred to stand up and risk death than to take cover on the burning sand"; "a white man who lives in these tropical regions remains uncomfortably hot, for his sweat-glands and pores are smaller and he cannot perspire so much as coloured peoples"; "the very cold, dry winters of the original homeland of these Mongolian peoples caused the body's sensitive blood vessels to be placed out of danger well beneath the skin . . . (and) . . . the body consequently took on a sallow tinge"—these are some examples of the folk-lore with which the environmentalist attitude is presented. Ignoring the post hoc fallacy of equating civilization and temperate climate, as well as the well-known exceptions to this association, the author leaves himself in the unenviable position of either admitting an inferior adaptability on the part of the white man (which is probably not true), or of sponsoring the idea that what is not good enough for the white man will do for the native (which is as unjust as it is politically explosive). As a geographer he is, of course, entitled to his own interpretation of the evidence, awkward though its consequences might be,

and he would be entitled to present it in a monograph; but as a teacher writing a textbook he should present both sides of a disputed theory, especially as in most "tropical" countries environmentalism is today seriously questioned, and in some is being actively disproved. His pupils twenty years hence are not likely to thank him for screening them from the other point of view. This book falls short of what we have come to expect from the Philosophical Library.

DOUGLAS H. K. LEE

DEMOGRAPHY.

By Peter R. Cox. Cambridge University Press, New York and London. $4.00. xii + 326 pp. + 3 folded tables. 1951.

This is one of a series of studies produced or in preparation for the Institute of Actuaries and the Faculty of Actuaries in Great Britain. It is one of the first works that meets to a large extent the combined needs of the population student, the actuarial student, and the public health administrator. Hitherto there has been little meeting between the student of population and the student of public health. The latter has given little attention to the development of demography in the last two decades, and the former has not often concerned himself in detail with the underlying influences on the course of mortality.

Cox discusses source materials and their appraisal, including not only vital registration but such diverse topics as immigration and morbidity. He deals with the statistical aspects of mortality, fertility, marriage, disability, and measures of population increase, including the gross and net reproductions, male and female. He has obviously benefited from his work for the Royal Commission on population, to whose papers he contributed an important monograph, and he is familiar with the newer critical material of Hajnal and others on the net reproduction rate. Throughout the whole work he shows a commendable caution in stressing the limitations as well as the uses of the available measures in population and vital statistics, and of population projections. The student who takes up the study of the significance of the net reproduction rate through this work will be safeguarded against the common tendency, at least until recently, to build more on it than it will really sustain and to imagine that it is an instrument for medication. His brief discussion of the use of "generation" mortality rates in the calculation of net reproduction rates (pp. 148-149) is of considerable methodological interest.

The illustrative material is mainly related to Great Britain, but this should be no serious disadvantage to students in the United States. It will in fact be a useful exercise for them to prepare analogous illustrations from the U. S. census, and other materials. To my mind this book is the best introduction available in its field at the present time, combining as it does conciseness, balance in the treatment of the different topics, and sound judgment in fields that are full of pitfalls for the unwary.

Since life tables are left to another volume in the series, the student should, in advance or simultaneously, make himself familiar with them from some other source.

ERNEST F. PENROSE

BIOMETRY

SAMPLE SURVEY METHODS AND THEORY. *Volume I. Methods and Applications.*

By Morris H. Hansen, William N. Hurwitz, and William G. Madow. John Wiley & Sons, New York; Chapman & Hall, London. $8.00. xxii + 638 pp.; ill. 1953.

These two volumes, totaling 1000 pages, provide a complete and authoritative treatment of the sampling survey methods used by the Bureau of the Census and other large governmental and commercial organizations. Research workers in the biological and social sciences who use the survey as an instrument will find a mine of useful information in these volumes.

Despite the excellence of these books a word of warning is in order. Bureau of Census sampling surveys have as their purpose the *estimation* of population characteristics. Many surveys in the biological and social sciences have a different primary purpose, namely the determination of relationships. In a given locality, for example, the "estimation" type of survey might focus on the *number* of cases of cancer in the community. The "relationship" type of survey, on the other hand, might examine the association between environmental factors and the incidence of cancer. There are some principles of good design which are common to both types of surveys. *However, it is possible that a sampling procedure which is efficient for estimation will be worse than useless for studying relationships.* For example, the "optimum" allocation of sample to strata (p. 219) is fine for over-all estimation, but if comparisons *between* strata are desired the allocation may be very poor indeed.

Moral: A "cookbook" use of these procedures may lead to unfortunate consequences.

IRWIN BROSS

STATISTICAL THEORY IN RESEARCH. *I. Basic Statistical Theory. II. Analysis of Experimental Models by Least Squares.*

By R. L. Anderson and T. A. Bancroft. McGraw-Hill Book Company, New York, Toronto, and London. $7.00. xix + 399 pp.; ill. 1952.

Research workers in the biological sciences who use statistical methods in their studies quite often find that the procedures available in their favorite cookbooks do not quite apply to the actual problem at hand. One very common difficulty is that the actual data are not *balanced*, i.e., the number of observations in the different cells may be rather irregular. Sometimes this lack of balance could be avoided by foresight on the part of the experimenter, but very often the available sources of data are such that balance could be obtained only by throwing information away. In still other cases the experimenter may actually try to set up a balanced experiment, only to be frustrated by the death of some animals or other vicissitudes of experimentation. Consequently it is desirable to have *general* methods of analysis, even though these methods are computationally much more laborious. Research workers searching for general methods will find an excellent presentation of the statistical theory and methodologies in Part II of this book. However, an understanding of this material does require considerable mathematical and statistical sophistication.

The simpler "standard" statistical techniques (such as analysis of variance) may be inappropriate because the mathematical model used in their derivation does not adequately describe the data. The Iowa State-North Carolina State "school" of statisticians has been especially concerned with this practical question of adjusting the technique to the actual situation. Anderson and Bancroft, in Part II, present numerous results obtained by this "school" of statisticians. Many of these results have not appeared before in book form.

Part I of the book is intended as a textbook, but is so condensed that it would be very hard going for anyone without some previous familiarity with the material. However, Part II is more than enough to insure this book a place on the bookshelf of statistically oriented research workers in biology.

IRWIN BROSS

DE OMNIBUS REBUS ET QUIBUSDAM ALIIS

THE INTELLIGENT USE OF THE MICROSCOPE. *First American Edition.*

By C. W. Oliver. Chemical Publishing Company, New York. $4.00. viii + 192 pp.; ill. 1953.

Perhaps because the microscope is introduced to the student so early in his career and in such a simplified version, an attitude of easy familiarity is engendered which, while not always maturing into careless complacence, often makes it very difficult for the student to make a later, serious reappraisal of the instrument in its more refined form. It is my own impression that few techniques in biology are practiced more atrociously than microscopy, and this seems to be true at all levels and with the finest instruments.

A book such as the one reviewed here would seem to be an excellent introduction to the subject for the biology student. It is modest in both size and price and does not overwhelm the uninitiated by an excessive amount of theoretical optics. Its virtue thus lies largely in the author's avoidance of the encyclopedic without sacrificing the fundamentals. It tells not only the hows but the whys of microscopy in simple, succinct terms. Although the book is not slanted to the young man in a hurry, the author is aware of his audience.

In addition to the excellent treatment of the components and accessories of the microscope, there is a chapter on selecting the right equipment. Here one can do no better than to quote the author's preamble:

> It is a waste of money and effort to purchase an instrument far beyond your probable requirements, when a simpler equipment will do all that is required just as efficiently and much more easily, but it is a great mistake to attempt difficult work with an indifferent instrument.

Included in this chapter is a section on second-hand instruments which should be read at least by all medical students who purchase their own microscopes.

A chapter is also devoted to illumination, a subject which is too often slighted by both the buyers and the makers of optical equipment. Since the lamp and the microscope must function as a unit in critical microscopy, the type of lamp is as important as the components of the microscope.

The use of filters for visual work and in photomicrography is practically presented, and the chapter on photomicrography is excellent in its discussion of principles, choice of equipment, and procedural directions.

The last chapter, on phase microscopy, has been added to this second edition and, although brief, is simple and clear. The textual adequacy of this chapter is marred by the poor low-power photomicrograph accompanying it. Few would purchase phase equipment for such unfortunate results.

A minor fault of an otherwise excellent book is the almost exclusive use of unfamiliar British-made instruments for illustrations and reference. The usefulness of the book in this country would be greatly enhanced by the substitution or inclusion of American-made instruments and illuminants.

EARL H. NEWCOMER

THE PRINCIPLES OF LINE ILLUSTRATION, *With Emphasis on the Requirements of Biological and other Scientific Workers.*

By L. N. Staniland. Harvard University Press, Cambridge. $5.00. xii + 212 pp.; ill. 1953.

Only occasionally today do we find in our scientific journals the quality of illustration that once characterized the research paper of some 25 or more years ago. To a large extent the camera has replaced the illustrator, and this change has come about not only because the camera has made an artistic skill and draftsmanship unnecessary, but because there has arisen the general suspicion that one need not believe the existence of that structure which cannot be photographed. This is particularly true in microscopical work, although the feeling extends to other areas. As the author points out, however, and as presumably some Chinese scholar did centuries ago, a well executed but simple drawing can save many words. With this in mind, the author has dealt with the techniques of line drawing which can be reproduced cheaply by means of the zinc block, aids to accurate drawing such as camera lucida and other projection methods, use of color in various ways, methods of graph, diagram, and map construction, and odds and ends of helpful hints. The emphasis is on biological reproductions, but the general usefulness of the book, which is clearly written and appropriately illustrated, is by no means so narrowly limited.

C. P. SWANSON

AN EXPLAINING AND PRONOUNCING DICTIONARY OF SCIENTIFIC & TECHNICAL WORDS.

By W. E. Flood and Michael West; pictures and diagrams by Charles A. Baker. Longmans, Green & Company, London, New York, and Toronto. $2.25. viii + 397 pp.; ill. 1952.

One of the hindrances to an understanding of science and technology is the jargon which must be mastered. This dictionary should do much to overcome such difficulties, for the explanations are clear and unambiguous. A check of some 200 biological terms indicates excellent coverage without sacrifice of scientific accuracy.

C. P. SWANSON

THE QUARTERLY REVIEW OF BIOLOGY publishes critical reviews of recent researches in all of the special fields of biological science. The contribution should present a synthesis or digest of the researches and a critical evaluation of them. A mere synopsis of the literature without evaluation or synthesis is not desirable.

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Material ordinarily taking the form of footnotes is set in small print and placed in the text and consequently should be written in a style so as to fit readily into the text. Acknowledgments are printed in the text in small type at the end of the article just preceding the List of Literature. Recent issues of the Quarterly should be examined for style as regards (1) section or subsection headings in the text, (2) literature citations in the text, and (3) List of Literature.

The subjects and authors of articles are selected by the Editors and members of the Advisory Board. Unsolicited articles which conform with the objectives of the Quarterly will be considered for publication.

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